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CONTENTS

	Page
Frontispiece	2
Editor's Outlook	3
The Organization and Work of the United States Bureau of Standards. George K. Burgess	7
Forgotten Chemists. Edgar F. Smith	29
General Introduction to a Discussion of the Hormones. E. M. K. Geiling	41
Helium and Natural Gas. C. W. Seibel	45
Nitrogen as a Plant Food. F. E. Allison	50
Materials of Construction. W. S. Calcott	59
Requirements for the Doctor's Degree in France. Atherton Seidell	65
The Use of Charts in Teaching General Chemistry. John A. Timm	68
A Test of Achievement in College Chemistry and Results Obtained by Its Use with Both High-School and College Classes. Fred C. Mabee	70
Doctorates in Chemistry Conferred by American Universities, 1922–23, 1923–24, 1924–25. Compiled by Callie Hull and Clarence J. West	77
Correspondence	100
Class-Room Emanations	103
Chemical Digest:	
High-School Chemistry and the Everyday Life of the Pupil	104
Publicity for Chemistry	104
Abstracts	107

The Lazy High-School Student; The Conditions of Chemical Change; On the Advancement of Science by Published Papers; The Worth of Knowledge; The Tensile Properties of Single Iron Crystals; Valence Theories and the Magnetic Properties of Complex Salts; Apparently Anomalous Protection against Oxidation; The Chemistry of Solids; The Isotopic Composition and the Atomic Weight of Chlorine in Meteorites; Photochemical Problems; The Determination of Traces of Mercury; A Comparison of the Lecture-Demonstration and the Laboratory Methods of Instruction in Science; Mechanism and Vitalism; An Electromagnetic Theory of Matter, Life, and Mind; A Scientist's God; Poison Gas for Home Use; Educational Values Derived from the Teaching of Science in the Elementary School; Detection of Nitric Acid and Nitrates in Concentrated Sulfuric Acid; Electronation; International Scientific Relations; Research in American Colleges; Ethylene Glycol—A Contribution of Chemistry to the Automobile Antifreeze Problem; Uses for a Broken Electric Light Bulb; Across the Table; Objectives of Science in Secondary Schools (Editorial); The Structure of the Atom; The Conduct of Laboratory Work in Elementary Chemistry; Objectives of High-School Chemistry; Science and the Medium; On the Molecular Scattering of Light in Liquids; Note on the Theory of Interionic Attraction in Strong Electrolytes; The Activity Coefficients and Transport Numbers of Solutions of Hydrogen Chloride in Methyl Alcohol; Regeneration in Tuned Three-Element Vacuum-Tube Circuits; Ionic Equilibria across Semi-Permeable Membranes; On the Attachment of Electrons to Gas Molecules.

Local Activities and Opportunities	114
Recent Books	118
A Few Moments with the Business Manager	121
'Round the World We Go	122

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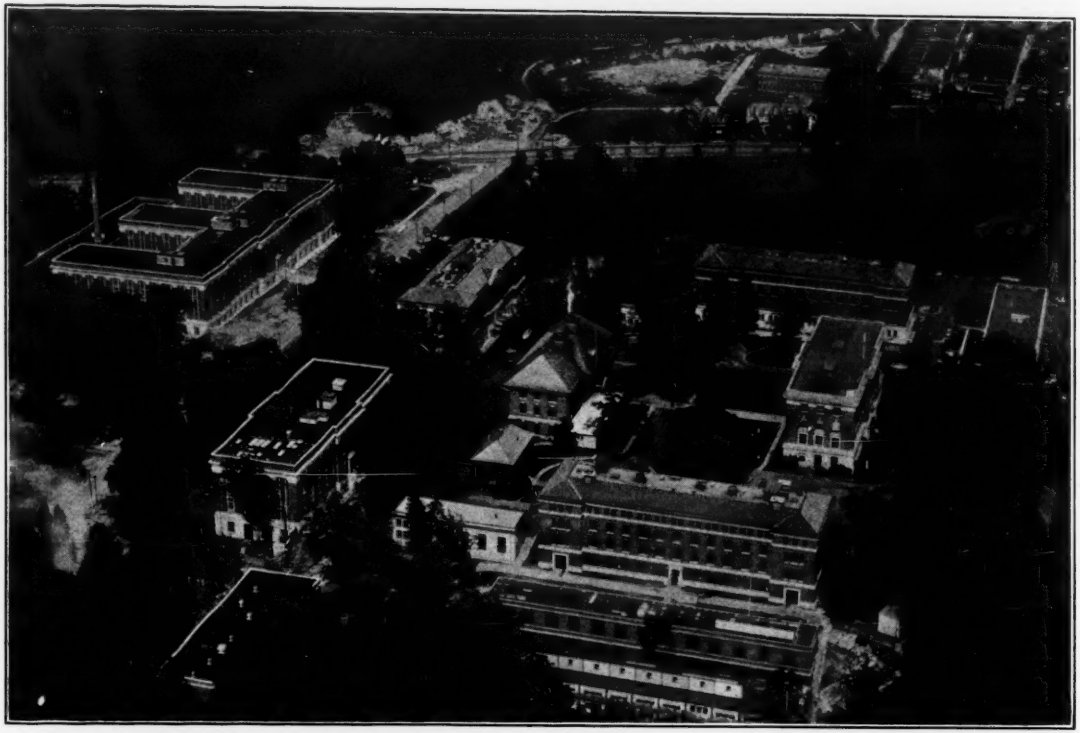


Airplane View of the Bureau of Standards.

EDITOR'S OUTLOOK

"Job-Holders"

NOT long ago, one of our popular humorous weeklies, proclaiming itself weary of hearing about the "big butter and egg men from the Middle West," began the publication of a series of sketches on other "big men." We, too, have experienced that tired feeling, but in our case it arises from hearing about "job-holders." Certain portions of the daily and periodical press have devoted so much editorial space to deploring and denouncing the inefficiency, uselessness, and general cussedness of government employees, both individually and as a class, that we long to read of at least a few "job-holders" whose motives cannot be construed as mercenary and whose activities are undeniably saving the nation more than they cost it.

Fortunately, this desire is in close accord with another project which we have considered for some time past—the publication of a series of articles describing the scientific work of a number of the government bureaus. To this issue of the JOURNAL Dr. Burgess contributes an introductory paper which constitutes a general outline of the work and organization of the Bureau of Standards. In succeeding issues, members of various divisions of the Bureau will describe in more detail the activities and some of the past accomplishments within their own particular fields.

As Dr. Burgess points out, much of the work of the Bureau of Standards calls for the solution of physical and engineering as well as chemical problems. In many cases the three are closely interwoven. Naturally we are primarily interested in the chemical side of the work. In so far as these articles may depart from matters purely chemical, however, they but serve to illustrate the truth that the chemist should be a man of extensive interests and broad general training, if he is to attack his task with the intelligence and effectiveness which it demands.

Grades and Scholarship

THE ancient question of the relationship of grades to scholarship is again dragged to light by the action of an honor senior at the University of Kansas in refusing a Phi Beta Kappa bid on the ground that "the grade system of our schools is a false criterion of scholarship and is a dangerous foundation for intellectual idealism and achievement." Whatever may be our personal views concerning this student's action, the fact remains that the problem which he resurrects is worthy of earnest consideration.

It is true that if the student in question enters the business world, he will find that promotion will depend on doing what the boss expects,

just as in school, grades depend on "doing what the Prof. expects." In any phase of life he will discover the relationship between reward and actual merit to be somewhat less than mathematically exact. Nature, herself, acknowledges no obligation to be just, as witness the manner in which the sins of the fathers are visited upon the children. Yet neither parallel nor precedent justifies the acceptance of a wrong as either inevitable or inconsequential.

The advancement of material civilization to date has been the accomplishment of men who have fearlessly pronounced the handiwork of nature somewhat less than perfect and who have sought to improve upon it. Our social civilization represents a similar attempt to introduce some nearer approach to justice into the natural scheme of things. That our civilization is a poor piece of work at best it would be folly to deny, but that we recognize it as an improvement upon a state of nature we give evidence when we seek to perpetuate it by "educating" succeeding generations.

Hence the charge that grades are not always indicative of scholastic achievement deserves a more serious answer than, "What of it?" In the final analysis the solution of the problem must always rest with the individual teacher. Every teacher has a more or less clearly defined idea of the objectives of his course. What he "expects" of the pupil is based upon that idea. The grade which he awards, in turn, depends upon the extent to which the pupil, in his judgment, fulfils that expectation. If there be a deficiency in the system, a need for better judgment, which is to say, for better teachers, is indicated.

Here it seems that for one problem we have merely substituted another, more complex and troublesome. From the administrative standpoint this is true. Particularly is it true that the selection and training of *chemistry* teachers presents a problem of vastly greater importance than present practices would seem to indicate. For the individual teacher, however, the matter assumes simpler proportions. None of us need wait upon the launching of movements or the perfection of administrative schemes to undertake the improvement of one teacher of chemistry apiece.

Concerning the JOURNAL

WITH this issue the JOURNAL enters upon the third year of its existence. It seems, therefore, not wholly inappropriate to reiterate, at this time, some of its general aims and policies and to present a few of the projects for the coming year.

One of the impelling considerations in the founding of the JOURNAL was the need of a medium for the publication of the papers delivered before the Division of Chemical Education of the A. C. S. In fulfilling that need it performs a two-fold function—

that of carrying the benefits of those meetings to a much wider audience than could possibly attend in person, and that of furnishing a permanent record of the thoughts there expressed. Nor is it the intention to limit the operation of these functions to papers delivered before the Division. Through our Contributing Editors, we endeavor to secure and publish addresses of interest to chemistry teachers presented at meetings of various local educational and scientific organizations throughout the country, except, of course, where the organizations in question maintain their own mediums of publication. The JOURNAL furthermore arranges to publish from time to time the results of researches on chemical education and articles on objectives and methods in the teaching of chemistry.

The Chemical Digest and Abstracts department is conducted with a view to furnishing teachers with a summary or at least a notification of the current periodical literature which is likely to prove helpful or interesting to them. In it are noted:

1. Articles on the teaching of chemistry.
2. Articles on science teaching or on teaching in general when their scope is broad enough to include principles and suggestions of actual value to the teacher of chemistry.
3. Articles on the philosophy of scientific or general education, when the subject-matter has some actual, though possibly indirect, bearing on chemical education.
4. Papers describing laboratory apparatus or experiments which are likely to prove valuable to the instructor in chemistry.
5. Papers describing research work of such outstanding importance that it obviously constitutes a definite advance in theory or practice in chemistry.
6. Articles describing applications of chemical processes or principles to the solution of problems of wide industrial or social significance.

We realize that, as yet, we can make no pretensions to completeness in covering this field. Completeness, however, is the goal toward which we are constantly striving.

Vital as we believe these services to be, we feel that the JOURNAL should constitute more than a repository for convention proceedings and an abstract of contemporary literature. Of all chemical workers, the teacher perhaps realizes most fully the desirability of a broad general knowledge of the applications of chemistry to the needs of modern civilization. The reception accorded the first two volumes of *Chemistry in Industry*, among both chemists and intelligent laymen, indicates clearly the popularity of the non-technical, semi-popular industrial article. Accordingly, arrangements have been made to publish a considerable number of such papers from time to time. It is felt that, in addressing a group of readers who may be confidently presupposed to possess a thor-

ough general knowledge of chemistry, a somewhat more scientific tone may be adopted than would be permissible in a newspaper or popular magazine discussion. In the main, however, the purely technical will be avoided and the general trend will be toward the semi-popular manner.

Numerous comments from our readers indicate that historical and biographical sketches are also of wide general interest. Such articles will continue to appear regularly.

The recently instituted Correspondence section is an outgrowth of the aim to make the JOURNAL more truly an open forum for the discussion of questions of general interest. Not infrequently some reader desires to take issue with or to comment upon ideas expressed by a contributor. Likewise readers occasionally desire to offer suggestions or to express opinions which do not readily lend themselves to expansion into articles of the usual formal type. Such contributions are here accommodated. This section furthermore endeavors to aid teachers in solving their teaching problems by undertaking the duties of an information bureau. When we are unable to immediately secure answers to questions submitted, we appeal to the readers of the JOURNAL for aid.

No one realizes more fully than do the editors that not every article published can be reasonably expected to appeal to every reader. In a group of individuals whose immediate problems and interests vary so widely as those of the teachers of chemistry must, such a condition is inevitable. Any attempt to limit subject-matter to papers of universal interest would necessarily result in a decided limitation of usefulness. The happy equilibrium to which the JOURNAL aspires is that at which it shall, each month, present some articles of interest to everyone and some which, though individually of limited appeal, shall collectively, through their diversity, serve all groups.

In conclusion be it said that the JOURNAL hopes to escape that aloofness which so frequently overtakes the growing publication and removes it from all intimacy of contact with its readers. Criticism, comment, and suggestions are warmly welcomed.

THE ORGANIZATION AND WORK OF THE UNITED STATES BUREAU OF STANDARDS

GEORGE K. BURGESS, DIRECTOR, U. S. BUREAU OF STANDARDS, WASHINGTON, D. C.

Foreword

In this article I shall endeavor to describe very briefly the organization and work of the Bureau of Standards, one of the service bureaus of the Department of Commerce. This Bureau is a national educational institution in the broadest sense. It has helped to educate the public to appreciate the value of exact standards in everyday life. It has helped its own employees to educate themselves, not only in their own particular fields, but in that of general science. For many years advanced courses in mathematics, physics, and chemistry have been conducted after working hours for the benefit of the younger members of the staff. These courses are sometimes given by Bureau men, but more often by someone from outside. Employees are encouraged to take up, at the local universities, work which will help them to obtain a college degree, or an advanced degree. Every year many of the younger men and women take up work of this sort.

The general staff meetings, held each week during the winter, serve to keep each employee informed of the work in progress in sections other than his own.

The research associate plan, described more fully later on, is really an educational scheme, for it has taught to our industries the value of research work.

I therefore feel that a thorough knowledge of what the Bureau is trying to accomplish cannot fail to be of interest to those charged with the important work of educating our young men and women. This first general article will be followed by others dealing with specific phases of the Bureau's work.

General Description of the Bureau

The Bureau of Standards was created by an act of Congress, March 3, 1901, in response to an insistent demand from American industries that the United States be made independent of foreign countries in precise measurements. While it is obvious from its title that the Bureau has something to do with "standards," the very wide field now covered by this term is usually not appreciated even by those accustomed to the use of exact measurements in their own particular work. Standards are divided into five classes as follows: (1) Standards of measurement; (2) standard constants; (3) standards of quality; (4) standards of performance; and (5) standards of practice. As an example of the first class, we may take the familiar measurements of length, mass, and time; while the second kind of standard is well illustrated by such a constant

as the mechanical equivalent of heat, the constant of gravitation, etc.; a standard of quality takes the form, usually, of a specification for materials so drawn up as to insure that a substance made according to the specification will fulfil certain requirements; standards of performance may be applied to all sorts of machines and devices, from photographic lenses to airplane engines; while standards of practice include various codes for the regulation of the construction, installation, and operation of buildings, machines, and appliances of all descriptions.

Any single institution covering the whole field of standardization must, indeed, be one of extremely varied activities; in fact, it must concern itself with every branch of industry and science. In order to deal with such a variety of work, it has been found expedient to organize the Bureau of Standards into eleven scientific and technical divisions, besides the office and operation and construction divisions. The staff of each division is made up of experts in some particular line of work, the divisional organization being dependent upon the character of the work rather than upon the kind of standards. The names of the technical divisions are as follows: Weights and Measures; Electricity; Heat and Power; Optics; Chemistry; Mechanics and Sound; Structural Engineering and Miscellaneous Materials; Metallurgy; Ceramics; Simplified Practice; and Building and Housing.

The employees engaged in clerical work form the Office Division, while those employed in the operation of the mechanical plant, the various shops, and the care of the buildings and grounds make up the Operation and Construction Divisions.

The location of such an institution as the Bureau, devoted to accurate scientific work, is of considerable importance and it is particularly fortunate in this respect. The buildings are all designed for the special class of work for which they are used, and stand on a tract of 43 acres on the outskirts of Washington, where there is much greater freedom from mechanical and electrical disturbances than would be found in a site nearer the center of the city.

The Bureau's Relations to the Government and the Public

While the importance of exact standards was recognized by the founders of our country, and although the constitution gives to Congress the power to "fix the Standard of Weights and Measures," it was not until March 3, 1901, as before mentioned, that the present national bureau was established. Prior to that time the limited amount of standardization work carried out by the Government was taken care of at the Coast and Geodetic Survey.

In accordance with the law creating the Bureau, its services are given free to other departments of the National Government and to State

Governments, while in general, when tests are carried out for private individuals or organizations, a nominal fee is charged. The relations of the Bureau to the other Government departments, to the public, and the industries are extremely varied and interesting.

It may be well to consider these relations somewhat more at length at this point, in order better to understand the work of the different divisions of the Bureau. One of the Bureau's most important functions is that of a testing laboratory for the other Government departments. It is obvious that it is to the interest of all concerned to place Government purchases on a sound basis of merit and it is with this end in view that the Bureau undertakes to make tests of the materials used in governmental work. The Government differs in no way, except in size, from a private industry. It is, however, larger than any single industrial organization, and its activities cover a far larger field. Therefore, by performing tests for the Government, the Bureau is able to keep in close touch with all the latest manufacturing methods. In addition to this routine testing work, it also acts in an advisory capacity and is frequently called into consultation by other organizations, such as the Federal Specifications Board, to aid in the drafting of specifications, rules, and regulations.

The Director of the Bureau is ex-officio Chairman of the Federal Specifications Board and of the National Screw Thread Commission and the chairmanships of many important committees are held by members of the staff.

The Bureau has just completed the important and difficult work of preparing a directory or handbook of specifications covering all supplies purchased out of taxes, and designed to be of special service to purchasing officers of the National and State Governments. This work has required the coöperation of almost every industrial group in the country, and is generally recognized as a remarkable step forward in standardization of public purchase requirements.

As before mentioned, it is absolutely necessary for the Government to require in its work the use of accurate standards of all kinds. The public can hardly be expected to appreciate the need for or the value of exact standards in its purchases, if the Government itself does not set an example by demanding the highest accuracy. The Bureau has, therefore, aimed to take a leading part in the education of the public in the matter of standardization and has always maintained the closest relations with state and municipal libraries, laboratories, and educational institutions. It has distributed a number of charts and pamphlets which are particularly designed to be of service in everyday life. It has also greatly aided the public through its frequent service as an impartial mediator in disputes between municipalities and public service corporations. Many of these disputes can be settled through the assistance

of an unbiased third party such as the Bureau, with far less loss of time and money than would be the case if they were carried into the courts.

One of the most effective ways in which the Bureau aids American industries is through its system of research associates. These associates are sent to the Bureau by an industry or group of industries to work on some special problem. The salary of the associate is paid by the industry but he has the benefit of the Bureau's equipment and the experience of its staff. The results of the work are published by the Bureau for the public benefit. During last year 63 of these research associates representing 48 firms and industrial groups were stationed at the Bureau.

With the foregoing general statements in mind concerning the Bureau and its work, we are now in a position to take up in greater detail the field covered by each of the scientific and technical divisions.

The Division of Weights and Measures

The original standardization work that was carried out by the ancients was in connection with the familiar measurements of length and mass. Standardization of these measurements is absolutely essential in any civilization, however primitive. The division of weights and measures may, therefore, be considered to deal with the fundamental work upon which all the rest depends.

This division is charged with the custody of the fundamental standards of the United States. It is probably not generally known that we have no primary standard yard or pound. Our fundamental standards of length and mass are the meter and kilogram which were sent to this country from France by the International Bureau in 1889. Our standard yard and pound are derived from these, which are duplicates of the international prototypes, kept in Paris. The working standards which the Bureau uses in making comparisons with weights and measures submitted to it for test are compared at regular intervals with the fundamental standards of the country, and thus our measurements are in reality referred back to the standards deposited in the International Bureau of Paris.

The Bureau conducts a large number of tests of sets of weights for various private and state institutions and for industries. As these tests require a great deal of time, it is not always possible for the Bureau to undertake all of the work of this nature that it would like to do. It is, therefore, important that its activities be confined to the testing of reference standards as the ordinary routine testing of weights is a problem which suitably belongs to the commerical laboratory.

The varied nature of the weights and measures work will be appreciated when one learns that the Bureau has four special cars for calibrating railroad track scales. Two of these equipments are high capacity box cars

especially constructed to hold a set of weights with a total weight of 80,000 lbs. By means of a crane attached to the car operated by a gasoline engine and a special truck, these weights can be loaded on to the scale and its reading compared with the actual load placed upon it. Such equipment is much more accurate and reliable than the ordinary single dead-weight test car which most railroads use for this purpose. The Bureau, however, also owns two cars of this type for less accurate work. The weights, in the larger test cars just mentioned, are well protected inside the car and are not subject to the wear and consequent variation which is bound to occur in the case where the car itself is used as the weight. During the fiscal year 1925, 18 master scales and 898 commercial scales were

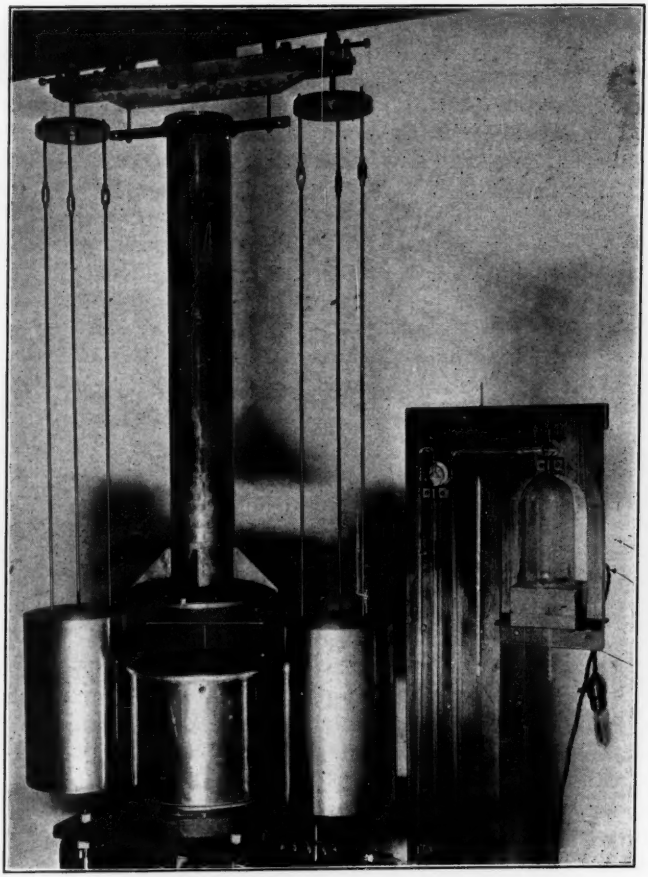
The fundamental standard of mass of the United States. The platinum-iridium kilogram kept under a double bell jar in the vault at the Bureau of Standards.

tested with these equipments; 65.2% passed the tolerance as compared with 38.2% in 1914 when the work was started—good proof of the value and success of the work.

For the inspection and calibration of mine scales, which in many cases are located in inaccessible territory, the Bureau maintains specially built motor trucks which serve the same purpose (to transport dead weights) as the cars mentioned above. These mine scale testing equipments have done a great service in helping to settle disputes between mine operators and the workers and in assuring the giving of honest weights to the consumer.

During the war, munitions were produced in vast quantities in this country. The making of shells and similar articles on an absolutely interchangeable basis required the use of a great number of accurate

gages. The Bureau took a leading part in assisting the military departments in this work. Its assistance took not only the form of routine testing of large numbers of gages, but also the manufacture of gage blocks by methods developed at the Bureau, an industry heretofore confined

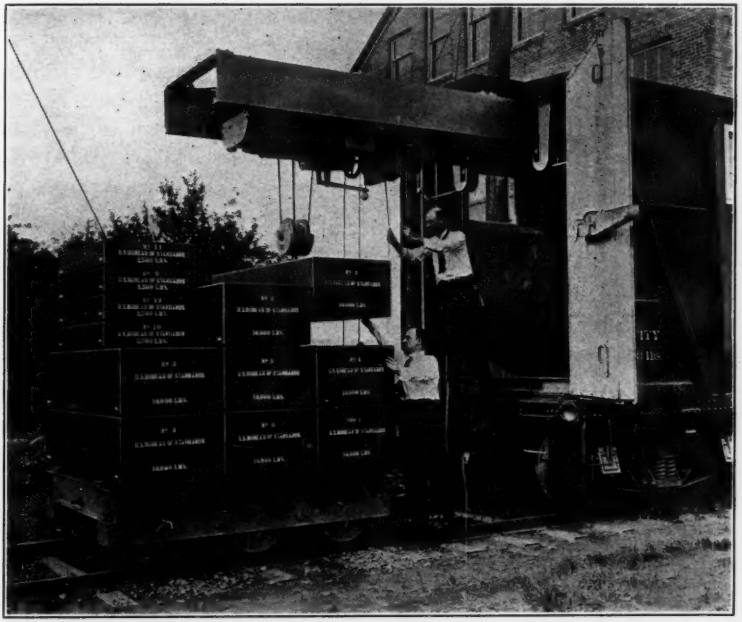


Apparatus used to determine the value of the constant of gravitation. Located in a small concrete room, 35 feet below the ground level.

entirely to one firm in Europe. This process has now been perfected and adopted by one of the leading makers of precision tools in the United States.

One of the laboratories of the weights and measures division is devoted

to the testing of clocks and watches. Many hundreds of time pieces have been tested for the United States Shipping Board, the War Department, and the public. Much of this work has been carried out in coöperation with the Horological Institute, and through this organization's plan for the certification of watchmakers a real advance has been made in the elimination of unskilled repairmen from this field. Other



Equipment for testing railroad track scales. The special crane and truck are used for moving the weights on to the scale. The Bureau has two of these equipments and two ordinary test cars.

laboratories are devoted to the testing of volumetric glassware, gas measuring appliances, and the administration of weights and measures laws.

The Electrical Division

As, in the case of nearly all other kinds of work, one of the most important functions of the Bureau, with respect to electricity and allied subjects, is the establishment and maintenance of the fundamental standards upon which all electrical measurements are based, including coöperation with similar institutions in other countries so as to secure international uniformity. This includes the inter-comparison of standards

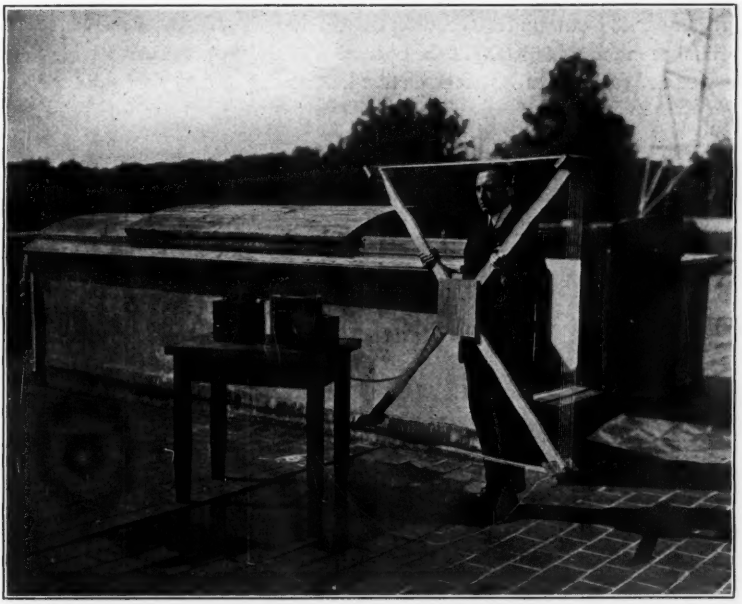
and extensive research in methods of measurement and the development and improvement of subsidiary and derived standards. These standards are utilized and the results of the researches are immediately applied in the testing of reference standards and instruments for manufacturers, testing laboratories, universities, research institutions, electrical utilities, utility commissions, engineering and other interests, and various agencies of the Government.

The testing of electrical instruments and apparatus is of two main classes: First, there is the standardization of reference standards and precision instruments for manufacturing and other institutions which themselves make or standardize instruments for commercial use or which conduct research work. It is through the work of such institutions that the measurements made in practice are referred back to the standards of the Bureau. Second, a limited amount of testing of commercial electrical measuring instruments and devices, such as radio apparatus, magnetic materials, ignition appliances, etc., is done chiefly for the purpose of keeping the Bureau in touch with the needs of the industries, of developing improved methods of manufacture, and of improving apparatus and materials. The greater portion of this testing is done for the Government services and takes the form of acceptance tests of materials purchased by other Government departments. This work serves the double purpose of providing information to be used in formulating specifications and of determining the quality of materials furnished in compliance with them. The research work has mainly to do with methods of measurement, the determination of the electric and magnetic properties of materials, and the development of those phases of electrical engineering in which measurement plays an important role. Electrical, radio, and illuminating engineering interests are all served by these investigations. The Bureau also renders important service both directly and indirectly to manufacturing and other industries. Much of this investigational work is on the more fundamental aspects of the principles involved, so that the results may be applicable to a class of problems rather than being limited to the one specific problem under investigation. Examples of this work are to be found in the correlation of magnetic and mechanical properties of iron and steel and in the study of galvanometers. Research work in radio communication, magnetism, radio-activities, photometry, gas engine ignition work, etc., is along lines quite similar to that in the more purely electrical measurements. Standards have been and are being developed, methods of measurements are being improved, and important special problems of significance to the industries and, in a number of cases, particular importance to the Government, are being investigated.

One of the valuable services which the electrical division renders to the Government and also to the industries and public is the routine testing

of incandescent electric lamps. For a number of years, all Government purchases of this class of material have been based on acceptance tests conducted by the Bureau. The standards of manufacture have thus been raised and much valuable information has been secured concerning the life and efficiency of these lamps. During the fiscal year ended June 30, 1925, the Government purchased over 1,500,000 incandescent electric lamps based on the Bureau's inspection.

The Bureau's work on dry cells and storage batteries has been of the



Experiments with a coil aerial on the roof of the radio building at the Bureau of Standards.

first importance and has resulted in better products and a reduction of unnecessary sizes.

The research work in the field of radio communication has yielded very important results. The construction of a satisfactory form of radio direction finder by means of which ships are able to determine the location of lighthouses, etc., many miles away, even when entirely obscured by distance and by fogs, has revolutionized navigation not only on the ocean, but in the air.

In drawing up laws governing radio transmission, the Bureau has given a great deal of assistance to other branches of the Government.

Of late years there has been a growing necessity for the formulation of safety codes covering industrial operations. The Bureau has taken an active part in the preparation of such regulations under the rules of the American Engineering Standards Committee, and a good portion of this work has been assigned to the members of the staff of the electrical division. Codes already published include the National Electrical Safety Code, the Code for the Protection of the Heads and Eyes of Industrial Workers, and the Logging and Sawmill Safety Code.

The telephone service standardization work is also of the first importance and as carried out under the direction of the Bureau of the Budget an annual economy of $69,000 in the operation of the Government's telephone service in Washington has been effected.

Division of Heat and Power

An idea of a portion of the work of this division is quite evident from its title, but the breadth of the field covered in the study of the phenomena of heat is probably not generally appreciated. An important part of the work of this division consists of the calibration of thermometers of all sorts, of the mercury in glass, platinum, resistance, and gas types, as well as pyrometers for measuring very high temperatures. The Bureau's work in aiding to place the manufacture of clinical thermometers on a more scientific and honest basis has been of great importance. The work in thermometry includes investigations of the melting points of various materials and the establishment of fixed points on the high temperature thermometric scale. Such work requires the use of a great deal of special apparatus and the highest degree of scientific ability. It is of great importance in many of the industries which are dependent upon the accurate control of temperatures. Through the Bureau's efforts agreement on an international temperature scale has recently been brought about.

Standard samples for use in calorimetric work are distributed by the Bureau and serve as reference standards in the industries.

The production of extremely low temperatures and the liquefaction of air and hydrogen and ultimately of helium are carried on by this division. The liquid air plant is operated once or twice a week to maintain the necessary quantities of liquid air in stock. Valuable assistance to the refrigerating industries has been given through the investigations conducted by the heat division, and somewhat similar work on the properties of saturated steam is now in progress.

An interesting part of the work of this division is that concerned with the investigation of internal combustion engines, particularly those used for the propulsion of air craft. Prior to the establishment of the Bureau's laboratory for this purpose, no testing of airplane engines under con-

ditions comparable to those of actual service had been carried out. The Bureau constructed a special laboratory containing a chamber within which an airplane engine could be placed and operated under the conditions of low atmospheric pressure and temperature met with at the high altitudes at which planes often fly. This work was of great value to our Air Service during the war and extensive investigational and development work on airplane engines has been carried out. Other work has been conducted in connection with automobile engines and appliances, and

A fire test in progress at the Bureau. This small house is furnished to simulate any desired occupancy and is then burned out to determine the temperature reached in a burning building.

very thorough road tests of automobiles have been made, using recording apparatus designed by the Bureau. Through the Bureau's tests, brake linings have been greatly improved, resulting in an estimated saving of $15,000,000 per year to the public. Important work on automotive fuels is now in progress.

The determination of the fire-resisting qualities of various materials is of great importance in building construction, and this division, in coöperation with various organizations, has conducted a thorough investigation of numerous building materials, fire-resisting coatings for

building columns, theater curtains, etc. Results of great value have been obtained and assistance has been given to many architects and engineers through this work.

The Optics Division

Optical instruments and optical methods are used in nearly all branches of science, and the purely scientific investigations carried out in the laboratory often have an important application in practical work. One of the sections of this division is engaged with the study of spectroscopy, that is, the determination of the spectra of the various chemical elements. Such work is of great importance in the analysis of certain substances, as, for instance, very pure metals, since impurities may be detected by this means, when they exist in such small quantities that they could not be found by the usual chemical analysis. In connection with spectroscopy, the Bureau has developed special photographic plates sensitive to the longer or red waves of the spectrum. As showing how a scientific achievement may very often have an intensely practical application, it may be noted that the photographic plates developed in connection with spectroscopic analysis proved to be the best obtainable plates for aerial photography. By using such plates, photographs can be taken through haze, smoke, and clouds which may happen to be below the airplane.

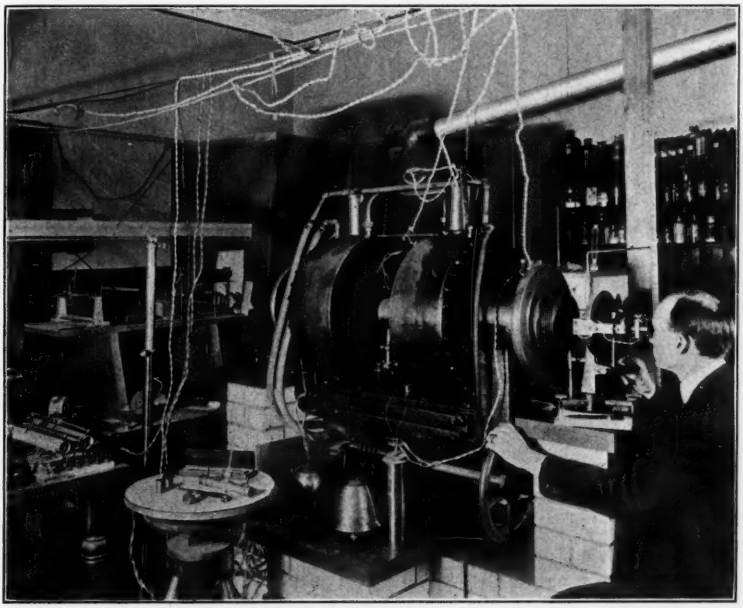
Important contributions have been made during the last few years to our knowledge of the relation between the spectra of the different elements. This work has included the verification of the so-called alternation law for arc spectra and the so-called displacement law which states that the spark spectrum of any element resembles in structure the arc spectrum of the element just preceding it to the left in the periodic table.

Another optical field of great importance to the industries is that of polarimetry. As the polarimetric examination of sugar is one of the most important tests of that commodity, the Bureau has undertaken the work of standardizing and in certain cases of adjusting polariscopes submitted to it by the sugar refiners. In this way, it has been of real benefit to this industry, as such instruments could not be readily procured during the war and many that were in use were in bad condition. The Bureau's laboratories have produced a number of the rare sugars for medical and other work. Practicable methods have been developed for the commercial manufacture of dextrose and levulose. A satisfactory method for determining the color of sugar has been developed and has solved one of the most difficult problems confronting the sugar industry.

The section of the Bureau devoted to colorimetry carries on some interesting and varied work. The study of colors and color standards is of great importance in many lines of industry, and the specification of a

given color is not an easy matter. Many kinds of oils and other liquids are sold on the basis of color, and the use of accurate standards in this work is of the first importance. This section has also assisted in the choosing of satisfactory colors for traffic and other signals, so as to secure maximum visibility.

Another section deals with atomic physics, radium, and X-rays. This is a new field of work in which development is very rapid. A better understanding of the structure of the universe will be the result of investigations such as this section is conducting. Practically all radium pro-



Measuring magnetic rotation of the plane of vibration of light. View in the polarimetry section of the Optics Division.

duced in this country passes through this section, as practically this element cannot be bought or sold without the Bureau's certificate.

Still another part of this division deals with optical instruments and has devoted a great deal of time to the study of the design of this class of apparatus. Nearly all these instruments were previously made abroad but a number of American firms are now entering the field and it is the desire of the Bureau to assist them in every way possible. A great many binoculars and other optical devices were required by the military and naval branches of the Government service during the war. Nearly all

of such instruments were first tested by the Bureau and rapid but accurate methods of determining the constants of optical instruments were perfected in this laboratory.

The radiometry section has investigated the germ-destroying properties of ultra-violet radiation in coöperation with the Department of Agriculture. Many studies have been made of the radiation from heavenly bodies, notably from the planets Venus and Mars, carried out during the summer of 1924 in coöperation with the Lowell Observatory at Flagstaff, Arizona. Some valuable information has been gained concerning the conditions existing on these planets. Other work has covered the heat radiation from different painted surfaces which has yielded important information concerning the best paint to use for household radiators, roofs, canopies, etc.

Interferometry or the interference of light waves has been used to measure small changes of length and has been employed by the Bureau to rule some very precise steel scales for the manufacturer of precision tools. These scales are so accurate that no correction has to be added or subtracted from their readings even in the finest work.

The Chemistry Division

The work of this division will perhaps be of greatest interest to my readers, yet as you will have noticed already, chemistry and physics are now so closely allied that it is hard to set any dividing line in the Bureau's work, as elsewhere.

A great deal of the work of the Chemistry Division is in coöperation with the other scientific divisions of the Bureau. Many of the problems which come to the Bureau for solution demand chemical analyses as a part of the work. This division also conducts many independent investigations. It likewise carries on many chemical tests for other government departments and distributes many standard samples of various materials which are used for reference purposes in the industries. This work alone is of the greatest importance. In certain of the work carried on by the Bureau, absolutely pure substances are necessary, and the preparation of these forms a part of the activities of the chemistry division.

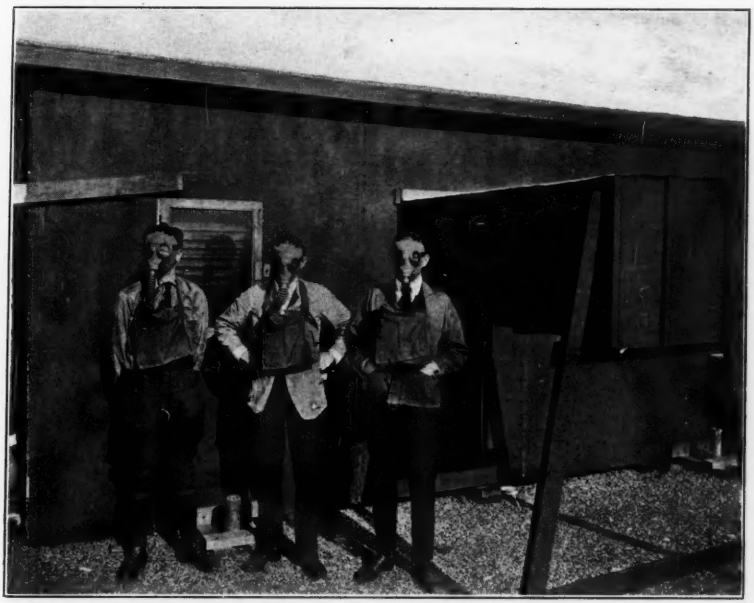
The field of electro-chemistry is becoming more important each year and in the solution of such problems the Bureau has taken an active part. Accurate data are lacking on a good many of the processes of electroplating and the work of the chemical division has been of real assistance to this industry.

In the case of the section of paints, varnishes, etc., as well as the one dealing with miscellaneous organic materials, a great deal of work is carried out for the General Supply Committee of the Government and

hundreds of samples are tested every year. Many specifications are likewise prepared for the Federal Specifications Board.

Another section devoted to gas chemistry has been largely employed during the past few years in investigating gas appliances and in determining upon the types of construction and conditions under which such devices should be used. This has a direct bearing on the public health and on fire hazards and is therefore of great importance.

Chemical work is also important in the testing of cement, bituminous materials, paint, varnishes, and soap. The Government is a large buyer



Ready to test the efficiency of gas masks for firemen.

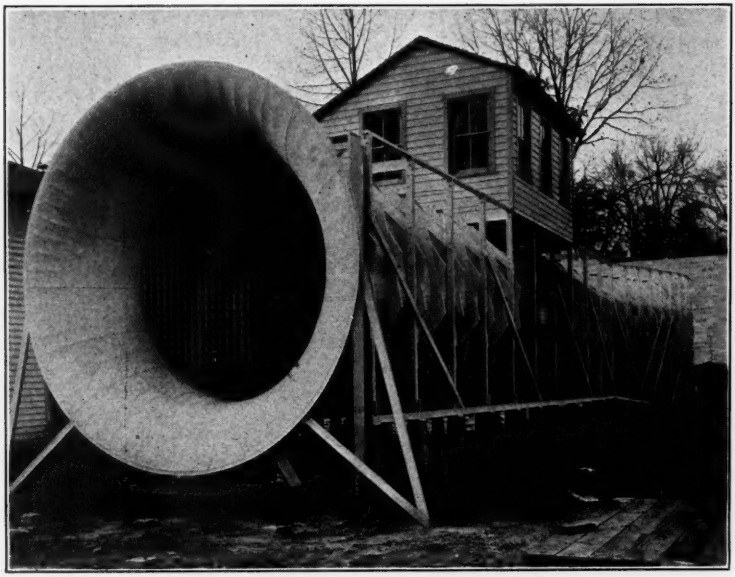
of all classes of these substances and nearly all of the acceptance tests, to determine whether the article supplied complies with the Government specifications, are performed by the chemical division of the Bureau.

Mechanics and Sound

The work of this division covers the physical testing of fabricated metal and to a certain extent of wooden structures, the testing of such appliances as water current meters, ventilators, fire extinguishers, pressure gages, fittings for heating systems, aeronautic and similar measuring instruments, the determination of the aerodynamical properties of air-

craft in the Bureau's wind tunnels, and studies of sound transmission and similar phenomena. One of the Bureau's wind tunnels gives an air speed of 75 miles per hour, another 80 miles, while 190 miles per hour can be obtained in the third. The first of these tunnels has a diameter of ten feet, so that very large models can be tested.

One of the sections of this division is devoted to the testing of fabricated structures and is equipped with machines capable of determining properties of any size specimen from the lightest airplane member to a full size steel column. The equipment includes the largest testing machine

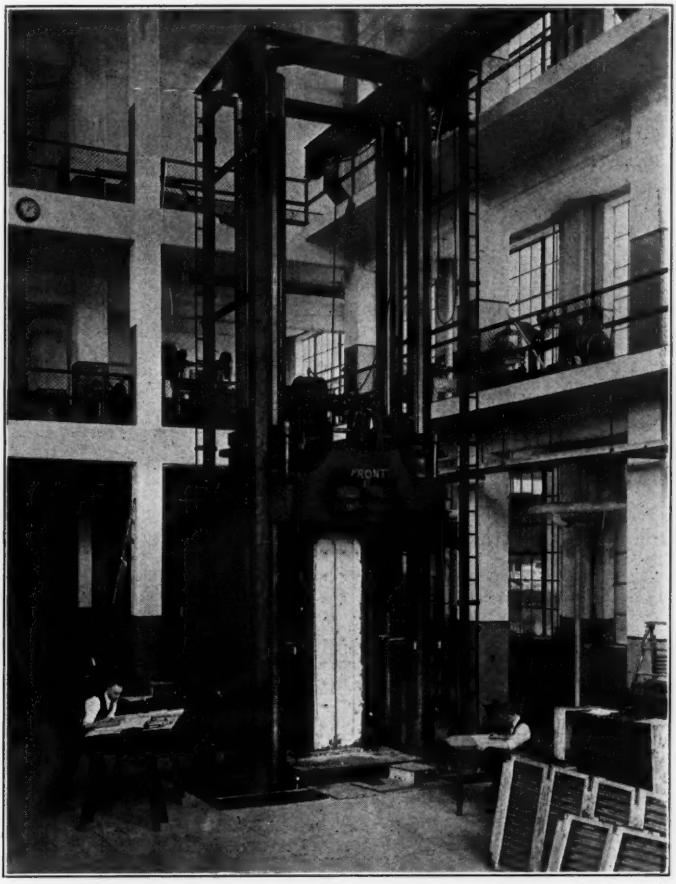


The large open-air wind tunnel at the Bureau of Standards. This tunnel is 10 ft. in diameter, and is used for testing large models, wing sections, etc. A wind speed of 75 miles per hour can be obtained.

in the world, with a capacity of 10,000,000 lbs., in compression, as well as two Emery testing machines, one of which is the largest high precision machine in existence. It has a capacity of 2,300,000 lbs., in compression, and about one-half that in tension. It is so designed that both tensile and compressive strength tests can be carried out with the highest degree of accuracy and with the maximum of convenience. The mechanical equipment of this section includes, beside the tensile and compressive machines just mentioned, a full assortment of torsional, cross bend, impact, and hardness testing machines.

Structural, Miscellaneous, and Engineering Materials

This division is preëminently the industrial division of the Bureau. Its work is carried on in close coöperation with the various industries

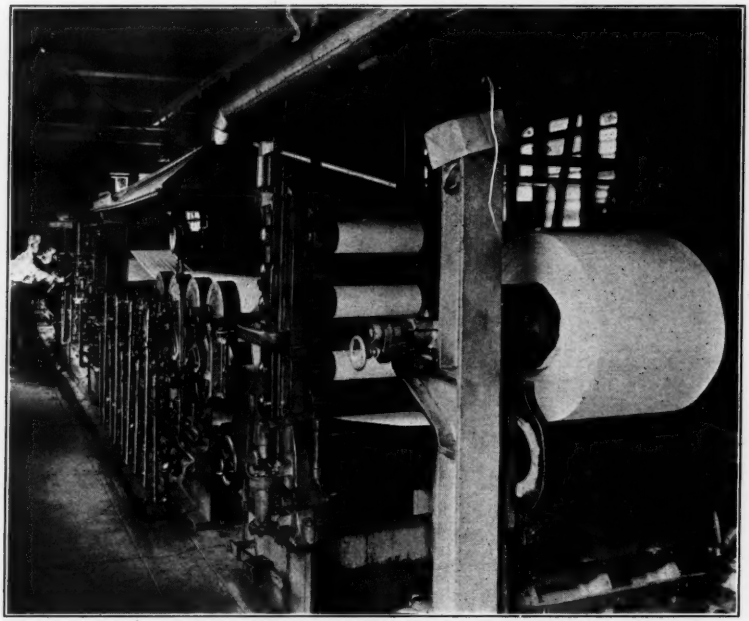


The largest testing machine in the world. Vertical compression machine with a capacity of 10,000,000 pounds, in the Industrial Building of the Bureau of Standards.

of the country and includes the investigation and testing of the ordinary materials used for constructional work, as well as rubber and leather goods, textiles, and paper.

The first section of this division deals with investigations of cement

and concrete. It is equipped to carry out work both in the laboratory and in the field, and conducts at all times a great number of routine tests of cement used in governmental construction work. This part of the Bureau's work has increased greatly during the past few years and requires the services of a small field force and three branch laboratories devoted to cement testing. These greatly aid the Government in rapidly carrying out its construction programs. The investigational work has



Experimental paper mill used for investigational work on new paper-making materials.

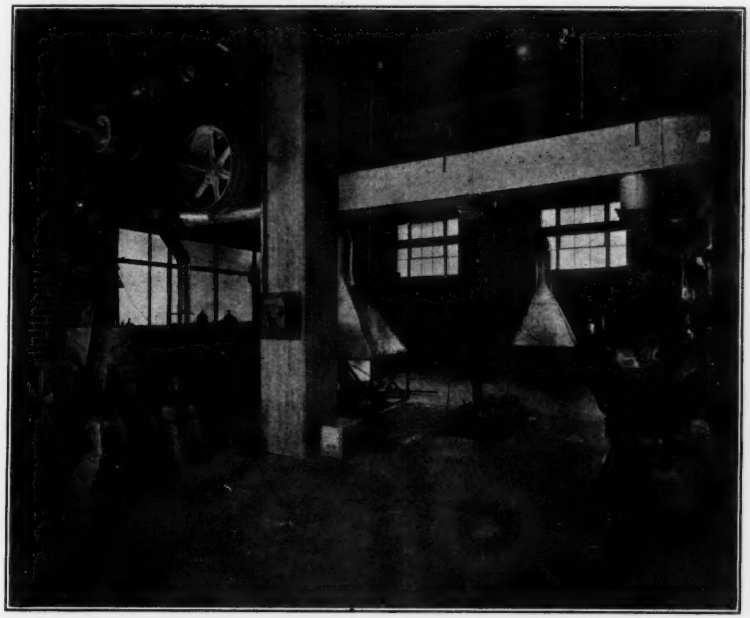
covered the strength of concrete, properties of waterproofing materials, weathering of building stone, sagging of stone with age, etc.

Closely allied to the work on cement and concrete is that conducted by the Bureau on lime and gypsum. This work includes investigations of the effect of different kinds of lime upon the properties of plaster, possible ways for improving the quality of lime plaster, and investigations of the best means for manufacturing sand-lime brick. Work has also been done on the use of reinforced gypsum and through these investigations the usefulness of this material has been greatly increased.

Other sections of this division are concerned with the testing of rubber, leather, textiles, and paper. This work necessarily requires familiarity

with all of the manufacturing processes used in the production of the finished articles and in order to enable the Bureau to test the relative merits of various manufacturing processes and the practicability of using new or unusual raw materials, a small sized but complete rubber mill and paper mill have been provided. The textile section is well equipped with cotton mill machinery and a number of special appliances for the rapid and accurate testing of cloth.

Special machines are installed for determining the resistance to wear



The experimental foundry in the Metallurgical Division. This division has a complete equipment of gas, oil, and electric furnaces for ferrous and non-ferrous metals and alloys.

of leather and textiles, and the durability of automobile tires. Investigations have also determined the power loss in tires of different construction.

The Metallurgical Division

This division is concerned with the thermal analysis and structure of metals, heat treatment and its effect upon metals and alloys, including the researches involved in determining the causes of metal failures, the study of heating and cooling curves, the investigation of hardening, annealing, tempering, cementation, determination of the critical ranges,

and the preparation of pure metals and alloys. In connection with this division, a complete experimental foundry for ferrous and non-ferrous metals is provided. Besides being employed in investigational work, it turns out quite a number of castings used in the Bureau's machine shops for the construction of special apparatus. Foundry practice in connection with various kinds of metals can thus be studied and a great deal of valuable information is also obtained concerning furnace behavior, the relative merits of various types of foundry sands, etc. For studying the numerous phases of the working of metals, a small-sized electrically driven rolling mill, a forging press, and other similar equipment has been installed. The laboratory devoted to the microscopic study of metals is unusually complete. Valuable work has been done here on the causes of failure of railroad rails and similar important problems. An experimental heat-treating plant in which the effects of various treatments on metals and alloys can be studied is maintained by this division. Many special investigations, such as the determination of the stresses in car wheels are continually carried on for the benefit of metallurgical industries of the country. In coöperation with the chemical division, analyses of metals are conducted, and pure metals and alloys are produced for scientific purposes.

A great deal of investigational work is carried on in this division to determine the best composition for brass, bronze, aluminum, and similar materials needed by other departments of the Government.

The Ceramic Division

The first section of this division is concerned with clay products, the development of new uses for clay, the replacement of imported by native materials, improvement of the quality of clay products, and in making routine tests for the Government involving the use of clays and similar materials.

An important work of this division is in connection with refractories of all sorts for use in furnaces and other places where high temperatures must be withstood. In coöperation with the section devoted to the manufacture of optical glass, a special form of glass pot has been developed using for the material a refuse from earthenware and wall-tile manufacturing plants. The use of these pots has revolutionized one portion of the optical glass industry, and they are already employed commercially by several glass makers.

Strength tests are conducted on hollow tile walls and constructions using architectural terra cotta and similar materials, and in coöperation with the Heat and Power Division considerable work has been done on the investigation of fire-resisting protective coatings for building columns. A section of the ceramic division is devoted to the manufacture of optical

glass. It should be noted that only a few years ago not a pound of optical glass was produced in the United States; all of it was imported from a few firms in Germany, France, and England. The Bureau foresaw that in the event of an emergency this supply might be greatly curtailed. After the commencement of the war in Europe, the Bureau undertook a complete study of the manufacture of this kind of glass and at the time the United States entered the conflict it had worked out a satisfactory process for producing the ordinary grades of optical glass. It was only after a long and exhaustive investigation that the proper technique for the operation of the furnace, the best design and most satisfactory materials for use in constructing the glass pots, etc., could be worked out, and the final result—the production of high-grade optical glass—is one of the most important accomplishments of the Bureau. This work has all been conducted in the closest coöperation with and for the benefit of the American glass industry.

Another section of the ceramic division is concerned with the study of enamels for use on metal ware. The production of satisfactory enamels for this purpose was an art previously known only in Europe and the development of satisfactory processes in the United States is of extreme importance. The causes of cracking of enameled ware have been discovered and remedies for this defect worked out so that this serious loss to the industry has been greatly reduced.

Simplified Practice

The division of simplified practice has for its object the reduction of waste through the elimination of unnecessary varieties of manufactured products. The division serves as a centralizing agency in bringing together producers, distributors, and users in coöperation with American industries.

Up to the present time 37 simplified practice recommendations have been accepted by the representatives of the industries. Many other recommendations are in process of acceptance and surveys are in progress in other lines.

Building and Housing

The work of this division includes gathering and distributing scientific, practical, statistical, and other information tending to encourage, cheapen, and improve construction and housing. It covers investigations for use in framing local building and plumbing codes, and a study of problems connected with city planning and zoning.

As a part of the division's activities information on the prices, production, consumption, and stocks of building materials, and on building activity is collected, analyzed, and distributed. Special attention is

paid to factors bearing on the housing problem. The work includes studies of building practices, and coöperation with efforts to reduce seasonal operation in the construction industries.

The last-named work has met with considerable success during the past year. Seasonal operation has been found to be due more to custom than to climate, and through its efforts the Bureau hopes to even up the curve of construction work, which will result in steadier employment to workers and reduced costs to builders and the public.

The work in connection with zoning is of great importance since each year a large number of cities and towns are adopting zoning ordinances. It is important that these regulations be prepared with care, so as to stand up under court decisions, and it is also advisable to have them as uniform as possible throughout the country. In this particular field the Bureau has been of real assistance.

It has also aided the individual home owner through written advice and replies to inquiries and by means of publications designed to give sound advice in home buying and construction to the general public.

New Gland Extract May Heal Broken Bones. Broken bones can be cured through the use of a new glandular extract that has already proved its usefulness in curing tetanus.

This is the information reaching here from Japan where experiments have been in progress with the hormone of the parathyroids that was isolated last year by Prof. J. B. Collip of the University of Alberta, Edmonton, Canada.

Professor Collip obtained from the parathyroid glands a hormone or extract which, when injected or given by the mouth, causes the amounts both of calcium and phosphate in the blood serum to rise. The parathyroids are four very small glands in the neck which lie near the thyroid gland or are embedded in it. His discovery was applied successfully to the cure of tetany, a somewhat rare disease usually found in children, and characterized by peculiar spasms.

A much wider utility for it is foreshadowed by the work done subsequently by Dr. Ogawa, in the surgical clinic of the Japanese medical academy of Keijo. As bone is so largely composed of calcium phosphate, a hormone which raises the amount of this substance in the blood might be expected to assist in bone formation. Rats with broken legs were found to produce twice as much new bone when fed with parathyroid glands as when not so fed.

Bone consists largely of calcium phosphate, and after a fracture fresh quantities of this substance must be taken from the blood for the formation of new bone. The slowness of the healing process seems to be largely due to the very small amounts of calcium and phosphorus in the blood.

The publication of the results in the case of human beings is awaited with the greatest interest, for there is reason to believe that the administration of parathyroid extract would not only hasten the healing of fractures in the young, but might render it possible in old age.—*Science Service*

FORGOTTEN CHEMISTS*

EDGAR F. SMITH, UNIVERSITY OF PENNSYLVANIA, PHILADELPHIA, PA.

Men—overshadowed, neglected, forgotten—are found in all walks of life. In the great Guild of Chemists they are numerous. One conversant with the volumes devoted to the history of this science will experience no difficulty in naming, in an off-hand manner, those whose achievements are recorded and whose praises are sung. The group of the "forgotten" contains many whose life-work has been most commendable. A few of these are here presented. Would that the hundreds of others could be called in at the same time.

These several pictures had never been seen until recently by the writer. It was on prowling about through early chemical publications—journals and text-books—that they were brought to light. Their discovery was the reward of this exceedingly worthwhile thing, *viz.*, a study of early chemical literature. Attention has been directed to it as one means of evoking an interest in the history of chemistry. To review the work of such pioneers is fascinating. It enables one to seize upon the personal element, so essential in vitalizing the great mass of facts accumulated during the centuries. Again, there continually crop out the efforts at a philosophy of our science—not given as such, for they represent in reality nothing more than observations of the moment, but are suggestive, and had they been applied might have borne fruit in abundance in the domain of chemical theory.

The writer rejoices that he is a chemist and gladly declares, "I am a chemist, and nothing that relates to the chemist can be foreign to my bosom," and hence has had much pleasure assembling the portraits and studying the writings of the following chemists of "by-past times," and would delight to find others pursuing the same lines of study.

Every chemist mentioned in this sketch deserves exhaustive study of his works. In brief, a biography of each of these eminent forerunners in our science is needed. Such biographies would make excellent doctoral theses.

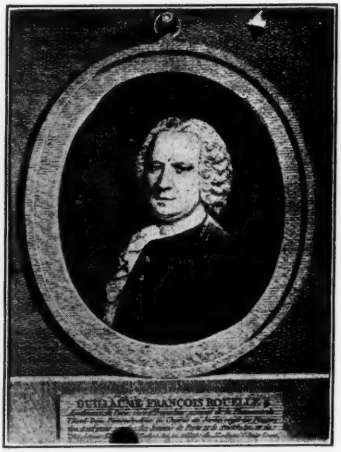
Their preparation would bring delight and profit to those who entered upon the requisite research.

Stephen Franz Geoffroy, a contemporary of Stahl and an adherent of the phlogiston school, was born in Paris. His father's house was a center to which came persons interested in the various branches of science. He was in daily intercourse with all the French scientists. Under the parental roof Stephen devoted himself exclusively to pharmacy, although at the local university he attended lectures on chemistry and medicine. In 1707 he became professor of chemistry at the Jardins des Plantes, and

* Delivered at the Los Angeles meeting of the A. C. S. under the title, "Neglected Chemists."

in 1709 was elected to the same chair in the Royal College. In 1699 he was admitted to the French Academy. He continued as teacher and investigator until 1731 when he died. Most of his researches were in the pharmaceutical chemistry field, but he became famous for his contributions to the doctrine of affinity and chemical combination. He thought upon the suggestions and experiments of Newton, for the latter's conclusions were quite promptly adopted by chemists, so that Stephen Geoffroy conceived the idea of ascertaining the relative forces of affinity (or attraction) among different substances by observing the order of decomposition they were capable of producing and gave the results of his observations in 1718 in the form of a table in which he arranged those bodies

STEPHEN FRANZ GEOFFROY
1672–1731



WILHELM FRANZ ROUELLE
1703–1770

whose affinities he had observed in the order of their attractions. Geoffroy gave his table as a first attempt, well knowing that much would be added to it. Rouelle made some corrections and added several columns to it.

One of the interesting facts in connection with **Rouelle** was that to him was entrusted the introduction of Lavoisier into the science of chemistry. It was also under him that Chaptal and Proust studied. Indeed, he was chiefly engaged in his day as a teacher, but he made valuable contributions as an independent investigator. Perhaps his comprehensive establishment of the idea of a salt is his greatest contribution. He distinguished between neutral, acid, and basic salts. During his day, in Paris, chemistry was presented by two teachers, one of whom discussed the theory of

chemical processes and the other the practical application of chemical principles.

Some rather interesting reminiscences of him are contained in Grimms' "Memoirs," Vol. 1, p. 48. A few may be mentioned:

"It was said that Rouelle was the creator of chymistry in France; that he was a man of great genius without cultivation. Before him nothing was known in France but the principles of Lemery. It was he who introduced the chymistry of Stahl and made known in France a science of which it was wholly ignorant, but in which such rapid advances had been made by a number of men in Germany. Rouelle was not able to read all their writings but his native genius was sufficient to lead him on almost without assistance, so that he ought in justice to be considered as the founder of the science in France.

"Unfortunately, many of Rouelle's students took to themselves principles and discoveries made by him. He revenged himself for their ingratitude by the reproaches with which he loaded them in his public and private lectures, and it was always known beforehand that at such a lecture the portrait of Malouin would be given, at such a one the portrait of Macquer in colors suited to the indignation of the lecturer. They were, according to him, ignorant blockheads, barber's apprentices, plagiarists. When the works of Pott, of Lehmann, or any other great German chymist, were translated, in which he found ideas analogous to his own, he said that he had been pillaged by them.

"He was a thoroughly honest man but with a character so rugged and uncultivated he could never know or practice the established usages of society."

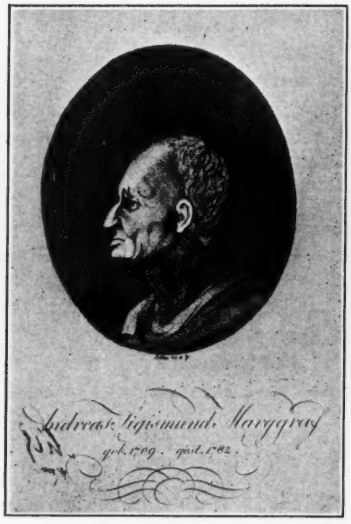
L. Crell said of **Andreas Sigismund Marggraf** that he was the most distinguished of German chemists of his day; that he had contributed much to make the chemistry of Germany known to foreigners. He was the second father, or better, the regenerator of European chemistry. His experiments were all developed along simple, natural planes. He aimed constantly at the Truth. He rejoiced to tell his followers or friends, without restraint, of his discoveries. He spun no theories, leaving that to others.

He was deeply esteemed by the French and also by the English, one of the latter, Robert Kirwan, saying, "Of this truly philosophic band, Mr. Marggraf, of Berlin, led the van."

Marggraf was born in Berlin, March 3, 1709. He was a pupil in chemistry of Neumann, Spielmann, Hofmann, and Junker. He also studied mining in Freiberg. He was most enthusiastic in his studies and by overapplication greatly undermined his physical vigor. He won fame and name. He spent a short time in Brunswick, but a love for Berlin drew him back there, and in 1754 he took charge of the Royal Chemical Laboratory.

His days were spent in uninterrupted work, and after 50 years of devotion to chemistry, he died August 7, 1782, mourned by his King, friends, and scientific associates. The basis of his character was seen in his friendliness to all men, his loving sincerity, and genuine discretion and good judgment.

Marggraf showed that the alkaline component of common salt was true fixed salt and differed from the alkali in plants; he showed also the distinguishing part of clay to be aluminium oxide. He was the first to recognize that calamine contained a true metal—zinc. He recognized magnesia; and gave a simple method for the isolation of phosphorus



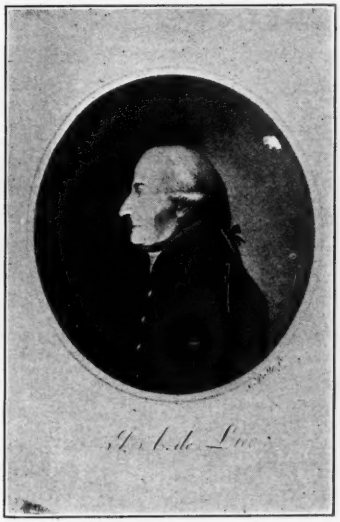
ANDREAS SIGISMUND MARGGRAF
1709–1782

JOHANN GOTSCHALK WALLERIUS
1709–1785

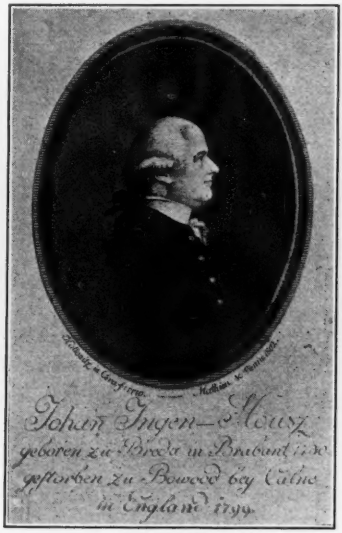
from urine. Platinum interested him greatly. He thought it a residuum of the amalgamated Peruvian gold ores, and probably nothing more than an iron made hard and brittle by an arsenic content. He made searching studies on water. The acids obtained from ants and their action upon metals constituted another remarkable study. The discovery of a real sugar in many native plants was unexpected. He observed the acid in fluorspar, and discovered a lost red paint much sought for by artists. He studied ten metals rather closely as to gravity, color, and ductility. Many minerals received his attention. Their synthesis was the hope he entertained. Among his pupils were Achard, Gerhard, Klaproth, J. C. F. Meyer, all of whose names were dear to chemists throughout the world.

Johann Gotschalk Wallerius was long professor of chemistry at Upsala. There was scarcely a division of the science in which he did not make valuable contributions. Take, for example, the domain of agriculture in which his chemical studies were fundamental, busying himself with the soil, the seed of plants, the influence of what may be termed fertilizers. Thus a few of his writings were:

1. *Dissertation de principiis vegetatione. Holm. 1751. Quarto.*
2. *Dissertation de artificiosa foecundatione immersiva seminum. Holm. 1752. Quarto.*
3. *Dissertation de origine oleorum in vegetabilibus. Upsal. 1761.*



JEAN A. DE LUC
1727–1817



JOHAN INGENHOUZ
1730–1799

To me his entire work has been most attractive and there arises constantly the desire to know more of the man.

Jean A. de Luc was a Swiss who discovered many facts of importance relating to heat and moisture.

He noticed the disappearance of heat in the thawing of ice about the same time that Joseph Black founded his ingenious hypothesis of latent heat upon it.

De Luc ascertained that water was more dense about 4°C. than at the temperature of freezing, expanding equally on each side of the maximum. He originated the theory, afterward re-advanced by John Dalton, that the quantity of aqueous vapor contained in any space is independent of

the presence or density of the air, or of any other elastic fluid. His favorite studies were geology and meteorology. Today de Luc would be classed with the group of physical chemists.

Ingenhouz was born in 1730 at Breda. After a preliminary training he studied at several Dutch and German universities, finally taking the degree of Doctor of Medicine, although he was not greatly inclined to practice medicine. The sciences attracted him strongly and he was particularly interested in electricity. He contrived many ingenious methods for the construction of electrical apparatus.

Being a traveler, it is not surprising that he was found in England as early as the year 1778. He stood in favor with, and indeed was an intimate friend of Benjamin Franklin.

It is said that he always carried with him in his pocket a small electrical machine with which he performed many experiments for the amusement of his friends.

In 1779 he published a series of experiments on vegetables in which he demonstrated their power of emitting "vital air" in sunshine and "nitrogen" at night time. He claimed to have prepared gunpowder without sulfur and directed attention to the inflammable gas which arose on the application of heat to a mixture of alcohol and sulfuric acid. Becher, it is claimed, obtained this same gas at an earlier date.

He must have been a rather interesting and curious little gentleman, because he wore a coat which was mounted with a set of buttons of platinum. He was deeply interested in this metal, succeeded in fusing it and shaping it into various forms, so that he actually became a walking advertiser of some of the interesting properties of platinum. One can't help but wonder whether it was the sight of this evening coat decorated with platinum buttons that so impressed Sir Henry Cavendish that immediately after his introduction for the first time to Ingenhouz, he precipitately disappeared and could not be found at the social function where they chanced to meet.

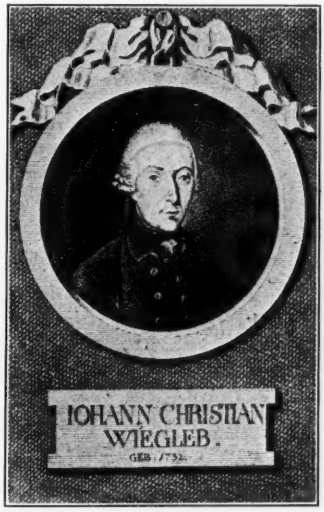
Ingenhouz was delighted with the burning of solid iron in vital air, and as a consequence of his pleasure in performing this experiment, is said to have carried about with him in his pocket a little bottle of vital air in which he used frequently to burn a piece of iron wire to the great entertainment of his female friends.

He married a sister of Professor Jacquin. While he was, in some respects, a dilettante in science, he contributed much to its promotion throughout the countries in which he traveled. Editions of his books appeared in French, English, and Russian.

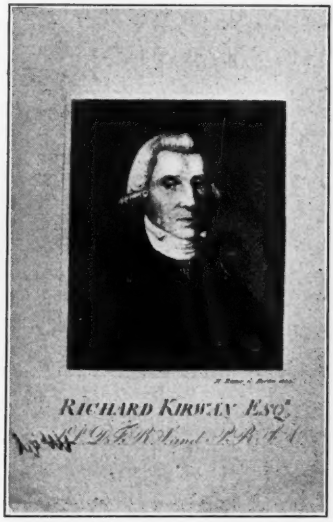
John Christian Wiegleb. German pharmacy and scientific chemistry owe much to this man. He was especially active in the writing of books,

which enjoyed a wide circulation. One of his most profound works was "The Revision of the Chemical Attractions of Bodies" (1777); also a "History of the Growth and of the Discoveries of Chemistry in Modern Times." In fact, he contributed much to historical chemistry. His translations of foreign books on chemistry were numerous.

Richard Kirwan was an Irish scientist. His experiments on the specific gravities and attractive powers of various saline substances formed a substantial contribution to the methods of analytical chemistry, and in 1782 gained for him the Copley Medal. He was one of the last supporters in England of the phlogiston hypothesis, for which he contended in his



JOHN CHRISTIAN WIEGLEB
1732–1800



RICHARD KIRWAN
1733–1812

"Essay on Phlogiston and the Constitution of Acids" (1787), identifying phlogiston with hydrogen. This work, translated by Madame Lavoisier, was published in French with critical notes by Lavoisier and some of his associates. Kirwan attempted to refute their arguments, but they proved too strong for him, and in 1791 he acknowledged himself a convert. His "Elements of Mineralogy" (1784) was the first systematic work on that subject in the English language. In Kirwan's book on "Water Analysis" are contained many interesting examples of the first efforts at the determination of bodies in the quantitative way.

Torbern Bergmann. All are familiar with the name of this exceedingly

able and industrious Swedish chemist who was hailed as the discoverer of Scheele.

However, it must not be forgotten that he had a great deal to do in the development of the doctrine of chemical affinity. It was he who also called attention to the precipitation of a number of metals, one by the other, the amounts of the metals precipitated being in very definite ratios to one another.

To him chemists are indebted for the beginning of quantitative analysis.

One of the most delightful and sympathetic sketches of his remarkable

TORBERN BERGMANN
1735–1784

VON DIEMANN
1743–1867

contributions was published in Crell's *Annalen* for the year 1787. It presents him in quite a different light from that in which he is exhibited in most of the histories of chemistry.

Overwork undermined his physical frame to such an extent that he died at an early age.

von Diemann. This Dutch chemist will be recalled when mention is made of the fact that he was one of those who early succeeded in decomposing water by means of frictional electricity, and was also one of the four Dutch chemists who discovered what was designated the "oil of the Dutch chemists" or ethylene dichloride.

His life was an exceedingly interesting one and upon study will disclose

the fact that he was by no means a member of the Guild of Chemists who should be overlooked.

Johann Friedrich Gmelin was celebrated for his achievements in both pure and applied chemistry. He wrote a number of excellent treatises on chemistry. His history of chemistry is an evidence of his diligence and his erudition. Nothing in modern literature is comparable to it. From it all later writers on the history of chemistry have drawn largely.

Franz Carl Achard studied the effect of electricity upon fermentation; submitted a device by which to utilize "vital air" in increasing the heat applied in melting processes; wrote on alloys; on the action of borax upon

JOHANN FRIEDRICH GMELIN
1748–1804

FRANZ CARL ACHARD
1753–1821

metals at their melting point; gave the reason for the solution of lime in boiling water; sought to imitate the ruby, sapphire, and other precious stones; endeavored to apply platinum in various ways, and extracted sugar from beets. Indeed, he was the first person to try out on a large scale Marggraf's method of obtaining sugar.

His writings on applied chemistry are truly voluminous, exceedingly valuable and demonstrate that he was keenly alive to the necessity of promoting chemical principles for the advancement of his own country among the sister kingdoms.

His life story is almost an inspiration. Just why his name has failed

to appear among the eminent masters of chemistry is difficult to understand. He confined himself almost wholly to the practical side of chemistry; theory did not have many attractions for him. His style of writing indicates a man of a rather aggressive nature.

He first made a platinum crucible and used it. He also made balloons and filled them with hydrogen (1789), then let them ascend.

Sigismund Friedrich Hermbstaedt was born 1760 in Erfurth, in the schools and university of which place he received his education. He was in the beginning a medical student who devoted much time and thought to chemistry. Indeed, for a while, he was an assistant to Wiegleb. In

SIGISMUND FRIEDRICH HERMBSTAEDT
1760–1833

JOSEPH VON JACQUIN
1766–1839

1791 he became professor of chemistry and pharmacy in Berlin. His activity seemed to have been mainly in the analytical field. It was in 1819 that he became professor in the University of Berlin. He died in 1833. He was in Germany an advocate of Lavoisier's doctrine. He translated Lavoisier's works and by his own experimental labors aided in the overthrow of the old phlogiston idols. He was very busy in promoting industrial chemistry.

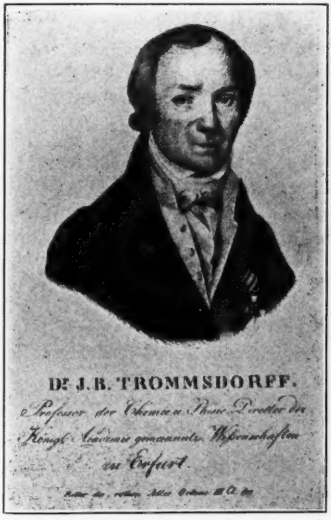
Joseph von Jacquin's contributions were highly regarded. His textbook on general and medical chemistry was translated into English and met with a very favorable reception. It will be enjoyed by present-day students. He taught chemistry and botany in the University of

Vienna, where he was successor to his father, Nicholas Joseph von Jacquin.

John Bartholomew Trommsdorff was born in Erfurth and succeeded his father in the professorship of chemistry and pharmacy in that ancient University.

He was exceedingly active in the field of pharmacy and chemistry and a voluminous writer. His works passed through numerous editions. He trained many men who became famous in the field of pharmaceutical chemistry.

Ambrose Godfrey's picture is included to call attention to the fact that



JOHN BARTHOLOMEW TROMMSDORFF
1770–1837

AMBROSE GODFREY
1669(?)–1756

in a rather remarkable publication made by him in 1724 he said, "The wonderful preparation of phosphorus-glacialis of which, since the death of one Mr. Bilger, I may without vanity call myself, for near these forty years, the sole maker in Europe; for on the strictest inquiry I could never hear of anybody, either at home or abroad, nor have I met in my late travels with any person that did prepare the solid and transparent phosphorus besides myself. Some, indeed, have obtained a few grains, but none can, as yet, produce the quantity of seven or eight ounces in one distillation, except myself. And though this preparation is entirely of my own finding out, yet I here confess with the utmost sense of gratitude that I am indebted for the first hints of the matter whence it is made, to

that ornament of the English Nation, the great Mr. Boyle, my kind master and the generous promoter of my fortune, whose memory shall ever be dear to me."

It will be recalled that the discovery of phosphorus was credited to Robert Boyle, yet there were many who opposed this thought. Evidently Boyle must have known something about phosphorus, otherwise his pupil, Ambrose Godfrey, would hardly have written the above lines.

New "Wool" Fabric Made from Wood. A new yarn, with the warm soft feel of lamb's wool, is now being made from the waste product of the artificial silk industry. U. S. Department of Commerce officials hold out a great future for the new fabric, which is already being manufactured in the United States as well as being imported from Italy, where it started.

The new "wool" is shimmery and dyes in beautiful colors. Combined with real wool in making serge and other goods, it improves its appearance, as silk does. It is not as strong as sheep's wool, and like artificial silk, does not wash as well. This is not a serious drawback for its use in textiles, as only a part of the strength of materials is necessary in clothing.

Chemically, the new yarn is the same as artificial silk, or rayon, for it is either made from its scraps, or directly from cellulose or wood fiber by the identical process. In the making of artificial silk, the viscose, or dissolved cellulose, is spun into a continuous thread like real silk from the cocoons of silkworms. The fibers used in the making of this artificial "wool" are short pieces from two to six inches in length, which are worked into yarn like sheep's wool.

The price of the fiber wool yarn will be from fifty cents to a dollar a pound, as compared with two dollars a pound for the real wool yarn, Department of Commerce officials say.—*Science Service*

American Chemists Make Many New Dyes. American chemists are making marked progress in the manufacture of dyes that rival the best imported from Germany before the war. The U. S. Tariff Commission reports that over sixty new coal tar dyes, most of which have never been made in this country on a commercial scale before, are now on the market. These are the dyes that have been imported in largest quantity up to last year.

Many coloring materials of high fastness for cotton, wool, and silk, that have been in great demand, were among those produced. The severe treatment which cotton clothes and other goods receive in the modern laundry has created a great demand for very fast cotton dyes. They are exceedingly complex and hard to make, and the patents were largely in the hands of the Germans.

At the present time the American chemical manufacturer makes 95 per cent of all the dyes that are used in American textile industries. In the year 1924, nearly 70,000,000 pounds of coal tar dyes were produced by 78 firms, while before the World War cut off the German market, seven firms were in operation and they made less than 7,000,000 pounds in a year.

Over 3,000,000 pounds of synthetic dyes were imported last year. Of these, one-half came from Germany, a third from Switzerland, and the remainder mostly from France and England.—*Science Service*

GENERAL INTRODUCTION TO A DISCUSSION OF THE HORMONES

E. M. K. GEILING, PHARMACOLOGICAL LABORATORY, JOHNS HOPKINS UNIVERSITY, BALTIMORE, MD.

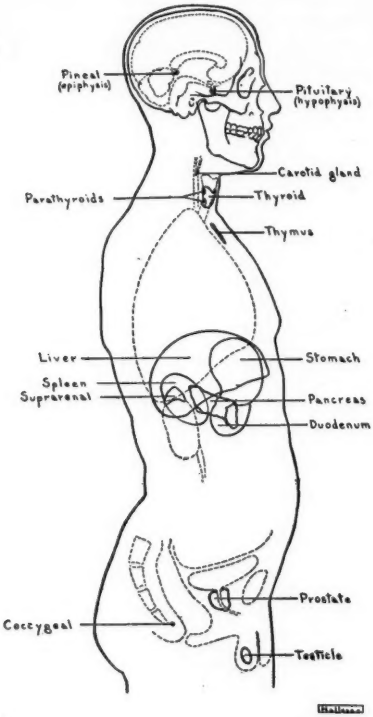
It is proposed in this article, which is the first of a series to be printed in THIS JOURNAL, to record briefly some general considerations concerning the glands of internal secretion, or ductless glands, and to describe some of the more important methods employed in the study of the functions of these organs. The discussion will be followed in subsequent issues by summarized statements, with occasional illustrations of the main facts, relating to our knowledge of the physiological functions of these so-called "regulators" within the animal organism.

It is no exaggeration to say that research directed towards elucidating the manner of action and the chemical nature of hormones, as the products of secretion of these ductless glands are called, has met with quite unexpected success, and, although our knowledge of this phase of physiology is still meager, new facts, many of great practical value and scientific significance, are being brought to light almost daily. In fact, every branch of biology and medicine has workers in the field of endocrinology, who are obtaining information which is of considerable value in their respective spheres of scientific endeavor.

It may be well at the outset to point out the difference between a gland of external secretion and one of internal secretion. In the former, the product elaborated by the cells of the gland finds exit through a duct. For example, the secretion of the parotid gland, one of the salivary glands, leaves by way of Stenson's duct which opens into the mouth on the inside of the cheek. On the other hand, the active principle or hormone formed by the cells of a gland of internal secretion does not escape through a duct, but is taken up directly by the blood stream and transported to different parts of the body, wherever it may be needed. The pancreas is illustrative of both types, in that its cells form an internal as well as an external secretion. The latter is the pancreatic juice which escapes into the lumen of the small intestine through the pancreatic duct. The former is the now well-known insulin which is formed by the islets of Langerhans which constitute an integral part of the gland. This hormone, or chemical messenger, is taken directly by the blood stream and carried to all the tissues where it plays an important role in the metabolism of the body carbohydrates. A deficiency of this hormone, brought about through disease of the islets of Langerhans, causes diabetes mellitus. Further discussion of this hormone or autacoid will follow later.

As a result of the attention which within recent years has been focussed on the subject of endocrinology, practically every gland within the body has had supporters in favor of its being possessed of internal secretory

functions. In the present stage of our knowledge, however, it would be rash to subscribe to this view. The most which can be said is that there is sufficient experimental or clinical proof to warrant classifying some of them as ductless glands, while in the case of others, the data are not as yet sufficiently convincing to justify them being looked upon as organs of internal secretion. Figures 1 and 2 are schematic charts showing the location in the body of the various organs belonging to the endocrine system. The pancreas, thyroid, parathyroid, pituitary body, suprarenals, the sex glands, the upper part of the duodenum, the liver, and the thymus are generally regarded as being the most important organs of internal secretion. In the case of the other structures shown in the charts there is still some uncertainty, though future investigations will no doubt show that a certain number of them at least possess hormonal functions.



SCHEMATIC CHART OF ENDOCRINE SYSTEM

D. APPLETON AND COMPANY

The methods usually employed in determining the physiological functions of the ductless glands are essentially laboratory experimentation and clinical observations. Of laboratory procedures the following are usually adopted:

1. Partial or complete removal of the gland from an animal (either by operation or through destruction by chemical substances) and observation of the resulting structural, nutritional, and physiological alterations.

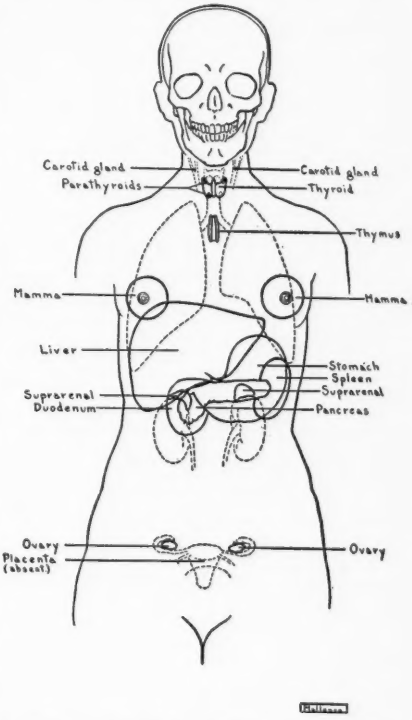
2. The whole gland or gland extracts, may be fed to or injected into a normal experimental animal and the changes thus brought about noted.

3. Animals from which a gland has been partly or completely removed may be fed with similar glands, or be injected with such gland extracts.

Clinical methods include the observation of patients suffering from an increase or decrease in function of any particular gland, the study of

symptoms or signs occurring after surgical removal of a diseased gland, and the changes which take place following the administration of gland substance or glandular extracts to such individuals.

It is of importance to note, as has been emphasized by Dr. Abel in his recent Kober Lecture, that the mode of action of any given hormone on a tissue or organ depends to a great extent upon the chemical or functional state of the latter. For example, epinephrine when injected into an animal originally produces a rise of blood pressure, but, as Dale found, when an animal has previously been given an injection of ergotoxin, epinephrine now causes a diametrically opposite response, in that there is a fall in blood pressure. In other words, the functional state of the body has been so altered by the previous injection of ergotoxin that the response to epinephrine has been completely altered. Other similar instances can be found in pharmacological literature.



SCHEMATIC CHART OF ENDOCRINE SYSTEM

It follows as a necessary corollary to this view that while each member of the endocrine system when examined individually may be found to be possessed of one or more active principles which have striking physiological properties, such as raising the blood pressure, causing the uterus and other smooth muscles to contract, lowering the blood sugar, or even causing structural alterations, its effect on the intact animal organism may be modified profoundly by the action of other glands. In short, the function of any particular gland must be viewed only as an integral part of a complex system in which each component exerts an influence upon the other members. At the moment this interrelationship of the glands of internal secretion is imperfectly understood but its importance is being more and more recognized.

We are beginning to realize very clearly that either excess or diminished

function of one gland is almost certain to influence the activity of several organs and as a result the sum total of disturbances produced in the body may often be far greater than would be expected. Some of the changes produced are secondary to the improper function of the gland whose activity is interfered with by the derangement of a primarily diseased gland. While our knowledge of this aspect of the subject is admittedly rudimentary, there are at present several striking instances where such an inter-relationship of the ductless glands exists. To cite but two examples: It has been known since remote antiquity that castration (depriving the body of the internal secretion of the testes besides rendering the subject sterile) causes striking alterations in the size and the structure of the hypophesis while the other internal organs are also altered. The outward expression of this internal glandular derangement is a striking alteration in the structure of the body. Some eunuchs may become abnormally tall; in others, growth may be stunted, while certain of them develop female characteristics, as far as the deposition of fat and configuration of the pelvis and breasts are concerned. The nature and extent of the changes produced vary with the age at which the operation is performed. The personality of such individuals is also very considerably changed as a result of this operation and consequent upsetting of the regulatory system. Another illustration of the interdependence of the ductless glands is found in the case of the removal of the pituitary gland, which causes a marked atrophy of the ovaries. These examples, as well as others, give adequate support to the conception of the inter-relationship of the organs of internal secretion.

It may be well to mention, too, that at times this inter-relationship takes the form of an antagonistic action, such as where epinephrine and extracts of the posterior lobe of the pituitary body prevent insulin from lowering the blood sugar. This would indicate that one of the functions of the adrenals and the pituitary gland is to balance the internal secretory activity of the pancreas.

We may thus look upon the normal functioning of the body (a very intricate and complex machine) as an expression of the coördinate activity of a number of internal secretory regulators, namely, the ductless glands which pour into the blood stream the active principles in such amounts as are necessary to maintain a balance of bodily activity. It should be remembered, however, that it cannot be implied that hormonal regulation is the only one in the body, though certain authorities such as Sir Arthur Keith have gone as far as to ascribe the individual racial characteristics of every man, woman, and child to the varying amounts of hormones elaborated by the endocrine systems of their bodies. Due regard must also be paid to the roles of the nervous and other systems in the normal functioning of the human organism.

HELIUM AND NATURAL GAS

C. W. SEIBEL, HELIUM DIVISION, BUREAU OF MINES, WASHINGTON, D. C.

Much has been said concerning the discovery of helium on our globe; how it fell to the lot of an Englishman, Sir William Ramsey, in 1895, to find it in the gas given off on heating a radio-active mineral "Cleveite" and how the American, Dr. Hildebrand, just missed making the discovery himself. Little has been said about the discovery of helium in natural gas and since this is the source of the present supply being used by the Army and Navy in lighter-than-air craft, it might be well to give it here, particularly since like many of the scientific discoveries, there is an interesting bit of history back of it. This history starts, of course, with natural gas itself.

C. W. SEIBEL
Helium Division, Bureau of Mines

On the west side of the Apsheron peninsula of Russia, near the city of Baku, stands an old fire worshiper's temple, whose eternal fires have been presided over by Parsee priests for more than 2500 years. The last of the priests has only recently departed. Our knowledge of natural gas goes back at least that far, for the fires that have burned through the ages in this old temple have been nothing more than ignited natural gas issuing from fissures of the rock promontory. It is rather astounding, in this progressive age, to think that what has proven to be such an important natural resource was allowed to remain undeveloped for so many centuries.

The early accounts of natural gas in this country are lost in early Indian myths and legends. We know for a fact, however, that, in 1775, George Washington dedicated to his country, as a national park, a tract of land located in West Virginia, on which there was a burning spring of natural gas.

An article in *Brewsters Journal* in 1830, describes how, in cleaning an old mill located on the banks of a small and rapid stream called the Canadoway, near Fredonia, N. Y., bubbles of gas were noticed coming up from the river bottom. Upon investigation, it was found that these could be ignited and it was with this discovery that our natural gas industry started. Arrangements were made to collect the gas, about 160 cubic feet in twenty-four hours, and it was piped to some 100 lights in Fredonia, N. Y., and sold for $1.50 per light per year. In 1872, a shallow well was

drilled at Newton, Pa., and the gas piped through a 2-inch line to Titusville, five miles to the south, and from there distributed to the various houses for domestic consumption, the first city in the world to be so honored. From this time on, the development of the industry was rapid. Statistics for the year 1923 show that 1,008,135 million cubic feet of natural gas were consumed with an estimated value at points of consumption of 240 million dollars.

The term "natural gas" is one that covers a multitude of gases, for there are a great many totally different ones to be found issuing from the earth. For the purposes of this article, however, they might be divided into two large classes, burnable and non-burnable gases. At the present time, industry concerns itself almost, if not entirely, with the use of gases of the burnable type. These are divided again into what are known as dry and wet gases.

Many gases in West Virginia, Oklahoma, Kansas, and Texas contain such substances as butane, pentane, hexane, etc.; substances composed of carbon and hydrogen and known as hydrocarbons. The substances mentioned, and those of higher molar weight, can be condensed into liquids more or less easily. Gases containing them are known as wet gases; the liquefied mixture is known as casinghead gasoline. This wet gas is processed to remove the easily liquefiable constituents, the remainder, which is largely made up of the burnable substances, methane or marsh gas and ethane, together with non-burnable nitrogen and small quantities of carbon dioxide, the gas found in soda water, is distributed for domestic consumption. Companies are always pleased to bring in a well of this type of gas, since in some cases it is possible to obtain as much as four gallons or even more of casinghead gasoline from each thousand feet of natural gas. The reason why a wet gas is desirable is not hard to find, with gasoline selling around 12¢ per gallon at the gasoline plant and natural gas at from 3¢ to 20¢ per thousand cubic feet, depending on location, demand, etc.

A dry gas is one composed chiefly of methane with varying amounts of ethane, nitrogen, carbon dioxide, etc. The more nitrogen the gas contains the less its value for heating, for nitrogen itself is an inert and useless gas as far as combustion is concerned.

Of the non-burnable natural gases, there are a number of different types. Gases are known which consist almost entirely of carbon dioxide, others consist chiefly of nitrogen. Some gases in Mexico contain sufficient hydrogen sulfide, a poisonous gas with a very disagreeable odor, to endanger life if breathed for only short periods of time, others contain sulfur dioxide, the gas given off by burning sulfur, while some are now known to contain appreciable amounts of the rare gases such as neon, helium, and argon.

Of the high nitrogen gases, one in particular from a well near Dexter, Kansas, deserves a position of importance in the scientific world. In 1903, early in the development of the natural gas resources of Kansas, a well was started in Cowley County, Kansas, near the town of Dexter. As can be imagined, the possibility of placing Dexter on the gas map occasioned no little excitement among the townspeople. The drilling operations were watched with interest and when a large gas flow was encountered at a depth of 400 feet, the owners of the well and citizens of the community were jubilant. The well was capped and invitations issued to those interested to come and see the gas from the well lighted. A small pipe was installed to lead a portion of the gas to some distance and the gas issuing from it was to be ignited, forming a large flaming jet. Imagine, then, the consternation of the assembled multitude when, upon opening the valve, the torch which was to ignite the gas was extinguished. All efforts to make the gas burn at that time failed. The invited guests and owners went home greatly mystified and dejected. Later, the well, which had a rock pressure of 120 lbs. per square inch and an open flow of about seven million cubic feet of gas per day, was allowed to blow into the atmosphere, with the thought that satisfactory gas might eventually be obtained. However, the gas could not be burned except by first heating it to a high degree. This type of gas, almost unheard of at the time, though several such are now known, occasioned considerable speculation as to its composition, so a sample was sent to the University of Kansas for analysis.

In making an analysis of natural gas it is customary to remove the various constituents one at a time until finally there is a residue that is arbitrarily called nitrogen. This nitrogen content normally runs from four to twenty per cent, varying with the field, depth, etc. You can imagine the surprise of the investigator, Dr. McFarland, when he discovered while working with this gas that it had an apparent nitrogen content of something more than eighty per cent. This led, of course, to a careful check of method and apparatus, but with the same result.

Oxygen	0.20%
Methane	15.02%
Hydrogen	0.80%
Nitrogen	83.98%

In order to eliminate all chance of error, this residue was treated in such a way as to use up the nitrogen, which would have left no residue at all if only nitrogen had been present. It was found, however, that an appreciable residue was left and that in no chemical way could it be gotten rid of.

At this time, helium had only been discovered some ten years and its

discoverer, Sir William Ramsey, was still actively engaged in various researches with it. Consequently the subject was still receiving considerable attention in the scientific press. It was therefore logical that the experimenters should turn their attention in this direction for an explanation. The problem was attacked by H. P. Cady and David McFarland, both of the Chemistry Department of the University of Kansas. Arrangements were made to test the residue for helium and in this instance there was no disappointment, for it was helium, and in

Official Photograph, U. S. Navy

The helium-filled *Los Angeles* cruising over Mount Vernon.

this particular natural gas sample, the helium content was something over one and eight tenths per cent.

The amount of helium obtained in the experiment was probably not more than would go in a small-sized thimble and yet something more than a week's effort was needed to obtain this small volume. Having a potential supply of this wonderful new element excited the experimenters to further efforts to produce an appreciable quantity for scientific study. The method used in its discovery was practically out of the question when it came to anything like large quantities.

By the use of cocoanut charcoal, maintained at a temperature of liquid air, 312 degrees below zero, Fahrenheit, the separation of helium from

natural gas could be made with comparative ease. Under these conditions the charcoal would absorb the constituents other than helium. The university authorities were persuaded to spend the money necessary to install a small liquid air plant. Their farsightedness in helping to develop research with this scientific curiosity has led to the development of helium for lighter-than-air craft. With liquid air at their disposal, Cady and McFarland made a field survey of some forty natural gases from various parts of the country for their helium content. It was this knowledge that made possible the dream of using helium for a balloon gas during the late war.

By this time, scientists all realized that this so-called rare gas, helium, had properties very similar to those of hydrogen and that it would actually float a balloon nearly as well and they also knew that unlike hydrogen, this new gas would not burn nor explode when mixed with air. In fact, no one except the scientists was particularly interested in helium and few of them had ever seen any of it. The man who could boast of the possession of a small quantity of this rare element was indeed fortunate, for was it not the substance whose existence was predicted from a spectroscopic examination of the sun at the time of the eclipse; whose presence on the earth was proven some thirty years later, in 1895; whose market value was two thousand five hundred dollars per cubic foot? Even at that price there were no excess profits to be had as the writer, who worked on the problem with Dr. Cady during the war period, can very well testify.

A little matter of arithmetic points out the fact that it would have cost something more than six billion dollars to have filled the *Los Angeles* with helium at the prevailing market price in 1915, and yet with this knowledge staring them in the face scientists suggested that very thing. Having initiated this seemingly impossible project, the scientists were called upon to solve its many difficulties. Research work in answer to the call now makes it possible to produce something more than a million cubic feet of helium per month, costing not $2500 per cubic foot as in 1915, but 3 cents a cubic foot, making it, as far as cost goes, quite comparable to the far less desirable hydrogen, which all goes to bear out the statement "Nothing is impossible."

Statistics show that 405,344,000,000 cubic feet of manufactured gas was consumed in the United States in 1924. This is the largest consumption on record.—*Compressed Air Magazine*

More than one-half of the window glass, one-third of the plate glass, and one-eighth of the bottles used in the United States are manufactured in Pittsburgh, Pa. It is interesting to note that the glass-making industry was started there as far back as 1797.—*Compressed Air Magazine*

NITROGEN AS A PLANT FOOD

F. E. ALLISON, FIXED NITROGEN RESEARCH LABORATORY, U. S. D. A., WASHINGTON, D. C.

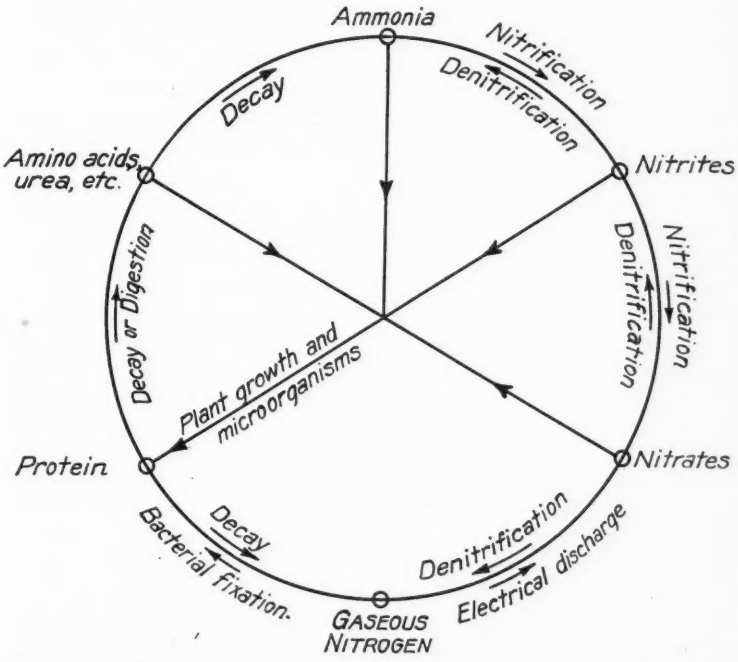
The plant is the workshop or factory of Nature in which energy is accumulated and various complex materials synthesized. The raw products utilized are simple compounds, such as water, carbon dioxide, nitrates, phosphates, sulfates, lime, potassium salts, etc.; the end-products are proteins, starch, sugars, oils, cellulose, gums, coloring matters, and an almost unlimited number of other compounds about which we know very little. The energy needed for these processes is absorbed from sunlight. The reactions taking place are largely unknown but undoubtedly follow the laws of chemistry, being hastened by organic catalysts called enzymes. The object of all of these processes is primarily reproduction whether it be by seed, tubers, or otherwise. The young plants must be provided with an abundance of energy during the first few days of growth until able to synthesize their own materials and hence the storage of concentrated foodstuffs in immediate proximity to the embryos.

Of the ten elements commonly considered as essential plant foods, namely, carbon, hydrogen, nitrogen, oxygen, sulfur, phosphorus, potassium, iron, magnesium, and calcium, nitrogen stands out in many ways as the most important. Not only is it deficient in many soils, expensive to supply, and difficult to retain, but it plays an exceedingly important part in plant metabolism, including both the constructive changes and also the respiratory reactions resulting in the destruction of carbohydrates and proteins. These reactions apparently take place within the plant cells, the synthetic reactions being confined largely to the leaves and active growing portions of the plants, while the respiratory changes which result in carbon dioxide production may occur throughout the plant tissues. Without doubt the nitrogen compounds present in the protoplasm of the cells as protein, amino acids, or other compounds are the active constituents which enable the tissue building to proceed. Without nitrogen there could be no life upon the earth.

The sources of nitrogen which are suitable for use as plant foods are very limited even though the compounds in which the element occurs are almost unlimited. Most of the nitrogen supply of the world exists as a gas, about 80 per cent of the air consisting of this element. But in the free state nitrogen is quite inert and unavailable for the use of higher plants except through the aid of bacteria. The remainder of the nitrogen of the world is found chiefly in organic sources, either in the tissues of growing plants and animals, or in the decaying residues found in the soil. There are a few important isolated deposits of nitrogen in the form of nitrates, the most important being the Chilean deposits of sodium nitrate. Combined nitrogen as found in Nature is, however,

for the most part a constituent of organic matter. As such it is largely unavailable for plant use but must be converted into simple water-soluble compounds. This brings us to a discussion of the nitrogen changes which normally take place in Nature. A diagrammatic representation of the nitrogen cycle is attached. This diagram is not complete but is meant to show only the more important changes and those which are best understood. Our knowledge of the chemistry of plant growth and decay is

The Nitrogen Cycle in Nature



still quite meager and in many cases the limited amount of data available on the subject is contradictory. It is, therefore, impossible at present to construct an accurate, detailed nitrogen cycle diagram.

The decomposition of organic nitrogen compounds in the soil, such as proteins, "humus," amino acids, and urea results chiefly in the production of ammonia, but under unfavorable conditions a slight amount of gaseous nitrogen may be formed. These changes are chiefly due to biological agencies and only to a minor extent to chemical action. Where the splitting up of proteins occurs in the digestive tract of animals the various

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digestive fluids are largely responsible, bacteria and fungi playing only a minor part. The end-product in this case is chiefly urea but this compound is very quickly converted into ammonia when in contact with soil.

The synthetic processes in the soil begin with the ammonia produced as a result of the decay processes. It is oxidized by soil bacteria to nitrites and these in turn are further oxidized to nitrates, the normal and most suitable source of nitrogen for the vast majority of plants. Nitrates seldom accumulate but are quickly taken up by the growing crop and to a minor extent are used by the soil bacteria for their own growth. If a crop is not growing on the soil there is some nitrate accumulation until leached out. This explains the common practice of planting "cover crops" to prevent nitrate losses during the late summer and fall when nitrates are being formed rapidly. Another avenue for the loss of nitrates is by denitrifying bacteria which destroy nitrates and liberate free nitrogen gas. This source of loss is small and may be neglected in considering a normal soil, well aerated and not excessively supplied with organic matter.

The nitrogen cycle is for the most part a list of changes in the combinations of nitrogen with other elements, but as already stated there are some reactions which result in the breaking of the bonds between this element and the others with which it may be combined. Nitrogen is thus lost to the system, but Nature has provided for a recovery by means of bacteria either growing singly or in symbiosis with certain higher plants, notably the legumes. These microscopic forms of plant life are able to do what the higher plants cannot, namely, fix free nitrogen, and thus the nitrogen balance in Nature is maintained at a certain level, this point depending upon the set of conditions prevailing at any given place. In addition to the fixation of nitrogen gas by bacteria, a slight amount of fixation results from electric discharges but this source of combined nitrogen is relatively small. The modern development of commercial fixation plants is, of course, greatly adding to the supply of combined nitrogen but this need not be discussed at this point.

A discussion of the forms of nitrogen which are suitable for plant growth logically fits in with a treatise on the nitrogen cycle. First and most important are nitrates but recent studies have tended to emphasize more and more that many other nitrogen compounds are used quite readily by many plants. Ammonium compounds, urea, various amino acids, possibly nitrites, and many others are almost certainly taken up by plants and utilized as foods. The utilization of ammonia is particularly a matter of great importance because it is almost universally present in soils. Nitrates are often decidedly deficient even though ammonia may be fairly abundant. This is due to the fact that nitrates are produced as a result of bacterial action and conditions which favor the growth of the

nitrifying organisms may be lacking. Vigorous nitrification particularly requires the presence of calcium carbonate, a warm soil, and sufficient aeration. Most of our humid soils contain little calcium carbonate and are too cold for rapid bacterial action until very late in the spring. This explains and justifies the common practice of using nitrate fertilizers for early spring applications, especially on truck crops. Some crops, such as corn, rice, and grasses seem to use ammonia nitrogen quite readily or at least can take up a large portion of their nitrogen in this form. However, most crops which are forced to grow in the entire absence of nitrate nitrogen do not grow as vigorously and cannot use the nitrogen as efficiently. During growth such crops commonly show dark green color and on analysis an unusually high percentage of nitrogen. It should be emphasized, however, that even though nitrates are still recognized as the most suitable of all sources of nitrogen for plants it is not always necessary or desirable to apply the nitrogen in this form. Most productive soils can convert organic nitrogen, ammonium compounds, urea, etc., into nitrates as fast as the crop needs them and the losses through leaching are kept at a minimum.

Closely related to the nitrogen changes in the soil are the carbon transformations. Both elements are important constituents not only of proteins but of the miscellaneous mixture of materials which we call soil organic matter. In ordinary cultivated soils the ratio of nitrogen to carbon is usually about 1 to 10. It is rather remarkable that soils even though treated very differently should tend to stabilize themselves so far as nitrogen and carbon are concerned at near this ratio. Soils which have just been put under cultivation for the first time may show a wider ratio than 1 to 10, but cultivation stimulates bacterial activities and a burning up of the excessive carbon. The existence of this fairly constant nitrogen-carbon ratio explains some of the facts which we observe in farm practice. For instance, a heavy application of an organic fertilizer, such as dried blood, having a narrow nitrogen-carbon ratio stimulates ammonifying organisms which decompose proteins and liberate ammonia. The ammonia may or may not be lost but, except in very sandy soils, is usually absorbed. On the other hand, the application of such materials as straw or sugar results in a burning up of the energy and an evolution of carbon dioxide. In the latter case the organisms which break up carbohydrates also use nitrogen compounds, particularly nitrates, for their own growth. Any crop which may be growing on the soil at the time may undergo nitrogen starvation. Later after the bacterial activities return to normal the nitrogen is again made available. The net result is a lowering of the nitrogen-carbon ratio to somewhere near the 1 to 10 normal.

Why have the soils of the United States become depleted and the

demand for fertilizers, particularly nitrogen-containing materials, increased? There are dozens of reasons that might be given but most of these relate to a change in conditions. Rich forest soils that have been accumulating their stores of plant food for generations have been suddenly subjected to an entire change in environment. Removing the trees and vegetation hastened leaching and erosion; cultivation did the same and in addition favored rapid bacterial action with the resulting destruction of organic matter. Intensive cropping usually meant less organic matter to be returned to the soil. A depletion of the lime supply and in many cases fewer legume plants decreased bacterial fixation of nitrogen. Soil fertility naturally dropped to a lower level and today in many cases a nitrogen equilibrium has been reached which is far below the original nitrogen content of the soils and below the point necessary for profitable crop production. As long as soils were rich and productive little effort was made to maintain them in that condition. It was cheaper to move to a new area. That period has passed and a permanent agriculture is now necesssry on a higher plane of production.

To what extent should an effort be made to increase the present productivity? This depends upon a very large number of factors, such as—value of farm lands, cost of labor, market value and demand for crops, soil type, climatic conditions, type of farming, etc. In Germany where labor is cheap, the population relatively dense, and food supplies in greater demand, an intensive agriculture exists and the crop yields per acre are about twice as great as in this country. Germany is an older nation and the farmers better understand how to farm so as to maintain soil fertility and under the conditions prevailing it is profitable to follow practices that would not pay in the United States. The nitrogen balance in the soil is maintained by means of good farming and heavy fertilizer applications at a much higher level than would be advisable in this country. If the United States were suddenly to put agriculture on such a high plane of production it is obvious that one-half or more of our acreage would need to lie idle since our present production is in many cases in excess of the demand. This is no place for a discussion of agricultural economics but suffice it to say that agriculture would be benefitted if placed on a higher level of production. A large percentage of the acreage now under cultivation should be allowed to remain idle and the remaining acres farmed more scientifically.

The question of nitrogen sources enters actively into any discussion of increase in productivity; likewise phosphorus, potassium, and lime but these cannot be discussed in detail at this point. A large percentage of our soils, particularly in the East and South, are so depleted in plant food that it is no longer profitable to cultivate them without heavy applications of commercial fertilizers. A part of the nitrogen may be sup-

plied by growing legume crops and by encouraging non-symbiotic bacterial fixation through applications of lime and phosphorus. The remaining amount must be supplied from commercial fertilizers and this amount must be rather large in many cases to bring the nitrogen balance back to a satisfactory level. In many of our midwest and western soils where the nitrogen supply is high all that is necessary is to maintain that balance. This can be done largely independent of nitrogen fertilizers but it is probably not economical to try to eliminate entirely this source of nitrogen. It is often cheaper to buy nitrogen than to get it by growing legume crops. Then, too, a small nitrogen application early in the growing season before vigorous nitrification gets started may give the plants an early start and prove very profitable on rather productive soils. When intensive farming is practiced, as on truck farms, heavy applications of nitrogen compounds will always be necesssry.

The effects of increasing quantities of nitrogenous fertilizers when applied to a crop growing on a soil deficient in that element are quite characteristic. These effects will vary with the crop, weather conditions, soil, method of application, etc., but speaking in terms of averages, if small applications of a readily available nitrogenous fertilizer are made at the time of seeding there will be an immediate response in growth of the young seedlings. This will be noted in the dark green color and larger plants. As the small supply of nitrogen added is used up the growth will slow down and the leaves become lighter in color. Plants growing on adjoining plots receiving heavier applications, but not excessive, will remain green and show very heavy growths of foliage and delayed maturity. Nitrogen is, therefore, a producer of foliage just as phosphorus stimulates root and seed production and postassium encourages sugar and starch formation. Small amounts of a nitrate fertilizer usually hasten maturity while large amounts retard seed formation and ripening. If the season is long enough so that there is time for development of the crop to maturity and there is an adequate supply of potasssium and phosphorus the abundant foliage production in crops produced primarily for their seed is usually not especially harmful and the excessive food is translocated into the seed. Often this is not the case and the nitrogen application slows down maturity to such an extent that premature ripening leaves a large percentage of the food materials still in the leaves. Obviously crops, such as cabbage, lettuce, spinach, and grasses grown for the leaves only benefit by quite abundant nitrogen supplies. In such cases the leaves are rather watery, less resistant to diseases and will not stand transportation as well.

The yield produced per unit of nitrogen applied to leaf or seed crops usually decreases with the increase in application. For example, 10 pounds of nitrogen applied in the form of ammonium sulfate may increase

the yield of corn 10 bushels per acre, 20 pounds 18 bushels, 40 pounds 25 bushels and 80 pounds 30 bushels. Doubling the application usually does not double the increase in yield except for the lower concentrations. Just how much nitrogen fertilizer is profitable is purely a question of farm economics that will vary for every set of conditions. Given those conditions it is not difficult to calculate the answer. The nitrogen balance in the soil could certainly be maintained profitably at a much higher level than at present but, as previously stated, good business would scarcely justify going to the extreme in this country and probably not even to the level that Germany has already reached; certainly not unless a large percentage of our poorer soils are allowed to remain uncultivated.

The amount of plant food removed from the soil annually by some of our common crops is shown in the accompanying table. These figures were obtained by using the average yields per acre as reported in the Yearbook of the United States Department of Agriculture and an average analysis for the various crops as given by Van Slyke. From these figures we may conservatively say that on the average about 35 pounds of nitrogen are removed annually by crops from each acre of cultivated soil not including that planted to legumes. To this 35 pounds should be added at least 15 pounds lost by leaching. To balance this total of 50 pounds there are various restorative agencies such as nitrogen-fixing bacteria, leguminous plants, manure and crop residues, and nitrogen brought down from the air by rain and snow. But even with our present low average production it has been estimated that only about 70 per cent of the total amount of nitrogen removed from soils annually is returned and hence soils are being depleted rather rapidly. Better farming methods would largely remedy matters but, as already stated, the country will undoubtedly come to rely more and more on commercial fertilizers to maintain the nitrogen balance and perhaps raise the level of production.

PLANT FOOD CONSTITUENTS REMOVED FROM THE SOIL BY CROPS

Crop	Av. yield per acre 1924	Nitrogen lbs.	Phosphoric acid, lbs.	Potash lbs.
Corn	23 bu.	36.1	12.7	25.4
Wheat	16 bu.	27.2	10.6	13.4
Oats	36 bu.	34.6	13.0	29.4
Buckwheat	20 bu.	77.5	13.5	60.5
Potatoes	124 bu.	26.0	11.2	37.2
Cotton	445 lbs.	68.2	21.2	47.8
Beets	17,800 lbs.	44.5	17.8	89.0
Tobacco	723 lbs.	42.7	5.6	56.4

The sources of nitrogen used chiefly in the past in fertilizers have been sodium nitrate from Chile, ammonium sulfate from by-product coke ovens and organic materials, such as cottonseed meal, fish scrap, and waste

products from the packing houses. These materials were for the most part mixed with acid phosphate and potash together with filler to give a rather low-grade fertilizer of any desired composition. In recent years there has been a decided tendency to use higher grade mixtures but this change must necessarily take place rather slowly since the farmers must be educated to use and demand the higher grade materials, and fertilizer distributing machinery must be redesigned to handle the more concentrated mixtures.

The nitrogen fixation industry, due partly to war stimulation, has grown very rapidly and the products are now being put on the market to supplement the other sources of nitrogen compounds mentioned. This development of fixation processes has been most rapid in Europe, but the United States is also making very rapid strides. Some of the products available from common commercial fixation processes, many of which have already been marketed on a rather large scale, particularly in Europe, are cyanamid, ammonium nitrate singly or in combination with ammonium sulfate, urea, ammonium phosphate, calcium nitrate, and ammonium chloride. With one or two exceptions these newer forms of nitrogen are as good as sodium nitrate and ammonium sulfate if properly used. Cyanamid is decidely the least satisfactory of all the newer materials and requires special knowledge of its properties for best results. Some of the other materials, particularly calcium nitrate and ammonium nitrate, readily absorb water in a moist atmosphere and then cake on drying; otherwise they are excellent fertilizers. Urea seems to be one of the best of the newer materials and will probably soon become a common fertilizer. The chemical and physical properties of all of these newer materials must be considered if they are used in the preparation of mixed fertilizers, especially the more concentrated combinations now being used. However, few difficulties are experienced in this respect that were not encountered with the fertilizer ingredients formerly used. In fact, the development of fixation plants is making so many materials available that little difficulty should be experienced in preparing mixtures. If one material isn't suitable in a given combination or for a particular crop then there are á dozen others from which to choose.

In conclusion, it should again be emphasized that while the lack of nitrogen more than any other element, is responsible for low crop yields in the United States there are many ways of overcoming this deficiency besides using commercial fertilizers. A permanent agriculture, placed on a profitable basis, demands, (1) that crop residues and animal manures be returned to the soil with as little waste as possible, (2) more leguminous crops, (3) a greater use of cover crops and other methods of preventing leaching, and (4) a stimulation of fixation by bacteria living in the soil and growing independent of plants. In many ways this last method of

maintaining the nitrogen supply is the most important of all since it may easily amount to 40 pounds per acre per year and that, too, without any great expense other than maintaining the soil in good tilth and productivity. The non-symbiotic nitrogen-fixing bacteria demand plenty of lime, phosphorus, and organic matter; so do most crops. Good farm practice does maintain these and at the same time largely maintains the nitrogen supply. Unfortunately, most of our humid soils are acid and bacterial fixation takes place very slowly. An organized wide-spread campaign for the use of lime would undoubtedly go far towards solving the nitrogen question in agriculture. Lime is, of course, only one of the many factors to be considered in profitable crop production but usually it should be among the first to receive consideration. Unfortunately, the farmer often resorts to commercial fertilizers to solve all of his troubles when the logical order would be first to put the soil in proper condition and then supplement Nature's sources of nitrogen supply with commercial fixation products.

New Canadian Methods May Revolutionize Cold Storage. Improvements in refrigeration methods which may result in widespread changes in systems of storing and shipping perishable foods are being put into effect by a group of shipping experts, fish distributors, and officials of the Atlantic Experimental Station for Fisheries of the Canadian government.

The central idea of the new method is that foods preserved by freezing should be chilled rapidly instead of slowly, as had been the practice in the past. Filets of large fish are wrapped in waxed paper and packed tightly in narrow cans, sunk in a rapidly circulating bath of very cold brine, kept constantly at a temperature near zero Fahrenheit. Small fish are wrapped and packed in whole. This process freezes the fish rapidly, preventing the formation of large ice crystals which occurs when the chilling proceeds at a slower rate and which is very deleterious to the fish when kept for more than a few days. Fish preserved by the new rapid-freezing method have been kept for six months, and when thawed and cooked could not be distinguished from freshly caught fish.

Still more rapid methods of freezing are being sought by the experimenters. Pieces of haddock were hung on wires and submerged in liquid air, kept in big thermos bottles, which furnished a temperature of some 300 degrees below zero Fahrenheit. At once the liquid boiled and hissed like water when a white hot iron is plunged into it, and in a fraction of a minute the fish was taken out frozen white like one's ear in a blizzard, and brittle as taffy. There was no moisture on the flesh, no slime, no crystals of ice in the tissue.

Liquid-air freezing is still too expensive for commercial use, but the price of the cooling agent could be reduced to a few cents a quart, refrigerating engineers claim, if the fish industry were to adopt the technique widely, since the manufacture of liquid air on a large scale for this purpose would bring a lower price.

The use is being considered also of solid carbon dioxide, the soda-water gas which is more easily handled than liquid air but is not so cold. Seventy degrees below zero Fahrenheit is the melting point of carbon dioxide, and like liquid air it gives a dry, pure cold.—*Science Service*

MATERIALS OF CONSTRUCTION*

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Iron and Steel
Iron Alloys
Lead
Aluminum
The Copper Group
Nickel
Construction Details
Wood and Rubber
Plastics
Textiles

The difficulty of finding a suitable material for the construction of chemical apparatus is, as is more and more realized, one of the major difficulties in the solution of industrial chemical problems. No industrial problem can be considered satisfactorily solved until someone, preferably the chemist, has found some suitable material in which to carry out the reaction on a large scale. A glance through the patent literature will show that the lack of a suitable material for constructing the apparatus was the stumbling block in more than one important process. In the Haber-Bosch ammonia synthesis, for instance, one of the most formidable difficulties was the absence of a metal combining the properties of high tensile strength, resistance to oxidation at high temperatures, imperviousness to hydrogen and resistance to its embrittling action. In spite of many attempts to circumvent this difficulty, the problem was not really solved till a suitable alloy steel was brought out by Krupp. Similar difficulties were encountered in the synthesis of methyl alcohol, or methanol, as iron and nickel were found to be undesirable catalysts.

The prevalence of lined equipment in chemical plants illustrates the same point. A lined piece of equipment is evidence that no single material has been found entirely satisfactory for the purpose, considering, of course, cost as well as chemical and mechanical suitability.

In most chemical work, if the corrosion phase of a given problem is serious, it is quite probable that no entirely corrosion-resistant material will be found, so that replacements at periodic intervals must be allowed for. The cost of the various available materials then becomes a serious problem, but this cost should not be figured only on the initial cost of apparatus, but as a cost added to the cost of the total amount of material which will be produced in a given piece of equipment before failure. Also the cost of the necessary shutdowns for replacements, taking into account loss of production while shut down, should be allowed for. When these factors are considered, the initially more expensive piece of equipment may easily be the cheaper in the long run.

Iron and Steel

Of the ordinary metals, iron (including cast iron and steel) and lead are the chief chemical plant materials of construction. Aluminum has a wide

* One of the Student Lectures delivered at the Tenth Exposition of Chemical Industries.

range of usefulness, as have also the nickel and copper alloys, but iron and lead are still the chief metals. Taking into consideration cost, ease of working, mechanical properties, and resistance to corrosion, iron in some one of its forms possesses all but the last property to a greater degree than any other metal. Even as regards corrosion, it resists alkali well in almost all concentrations and is, in fact, almost standard for handling alkaline solutions of all sorts. In addition, it is practically unattacked by concentrated sulfuric acid, or the so-called "mixed" acid, a mixture of concentrated sulfuric and concentrated nitric acids, so that it can be used for handling sulfuric acid in strengths above approximately 85%. As sulfuric acid is the most important single chemical, and more reactions are probably carried out with it than any other one reagent, this property of iron, together with its resistance to alkali, gives it a wide field of use. Nitrations and sulfonations, for instance, are commonly carried out in iron, as are the manufactures of sulfuric acid by the contact process, alkalies, etc.

Many other reagents, if anhydrous, do not attack iron; liquid chlorine, liquid sulfur dioxide, liquid hydrocyanic acid, etc., are shipped in steel tanks.

Iron Alloys

On account of their otherwise excellent properties, many attempts have been made to improve the corrosion-resisting properties of iron and steel, but, while this has been accomplished in various ways, it has always been at the expense of one of the other valuable properties. The silicon alloys, such as Duriron and Tant-iron for instance, are resistant to the action of almost all acids but hydrochloric, but have simultaneously lost the characteristic toughness and ease of working of iron, and have become hard and brittle and more expensive. On account of their high resistance to dilute acids, however, they are widely used, but only in shapes that can be cast. This fact restricts their use chiefly to relatively simple pieces of equipment; also, they cannot be repaired "in the field."

Another class of alloys gradually coming into use in the chemical field is that containing the chromium nickel alloys of the "stainless steel" type. Except for cost, these alloys are very satisfactory, being tough, strong, highly resistant to dilute acids (except hydrochloric), and workable into many shapes. They are, however, five or six times as expensive as ordinary iron or steel, and so can be used only when a correspondingly greater life can be expected from the equipment. These alloys are also quite resistant to oxidation, even at high temperatures.

Lead

Lead, probably the second most important chemical works metal, derives its importance from its peculiar physical properties and the fact

that it is highly resistant to the action of dilute sulfuric acid, and but slowly attacked by many weak acids or acids in low concentrations. Like other metals, it is attacked by hydrochloric acid. It is very easily worked, either in the field or in the shop, and the ease of repairing it offsets, to some extent, its relatively poor mechanical properties. Its low strength necessitates the use of a stronger supporting material, and even then it frequently buckles, due to slow creepage. Its low melting point also limits its use. Apparatus is frequently homogeneously lead-lined, the lead being soldered or tinned to the steel, and in some cases mechanically fastened as well.

Aluminum

Outside of lead and the ferrous group, the metals most used are probably aluminum, the copper group, and nickel. Aluminum is chiefly characterized by its high resistance to organic acids and to concentrated nitric acid, and by the ease with which it is attacked by the halogen acids and alkalies. It is peculiar in that its high resistance is due, not to the metal itself, but to a surface layer of oxide or hydrated oxide. Metallic aluminum, unprotected by the surface layer, is readily attacked by water, or even by the moisture of the air; however, a surface film forms almost instantly on exposure, and this surface layer, partly on account of the fact that aluminum salts are rather weak combinations and readily hydrolyzed, is quite resistant. Aluminum has therefore been successfully used for such acids as glacial acetic, phthalic anhydride, etc. Another advantage of aluminum for many purposes is the fact that its salts are white and do not discolor the product. Even small quantities of chloride stimulate the corrosion of aluminum, a fact which should always be borne in mind. The relatively low tensile strength and softness of aluminum also tend to limit its use to some extent.

The Copper Group

The copper group of alloys presents another interesting peculiarity as regards corrosion resistance. Copper itself, for instance, is hardly attacked by concentrated hydrochloric acid, but, in the presence of air, corrosion takes place rapidly due to the steady oxidation and solution of the oxide. The copper alloys are therefore restricted to conditions where severe oxidation and severe acid corrosion do not take place simultaneously, as, for instance, in the handling of weakly acid solutions.

Copper can be used for handling glacial acetic acid, while brass and bronze valves are largely used in connection with faintly acid solutions of all sorts, unless oxidizing in nature. Where condensers are cooled with salt water, brass tubes are again used. Copper is also resistant to alkalies, with the exception of ammonia in organic chemical work; the amines, on account of their similarity to ammonia, act upon copper in the presence of air.

Nickel

Nickel is used at present chiefly as monel metal, a nickel copper alloy, and as the metal itself. Monel metal is the more popular form, due largely to the much greater ease of working. To a certain extent it combines the corrosion resistance of nickel with the workability of copper, and is consequently successfully used under mildly acid or, other circumstances being favorable, even strongly acid conditions. It has high tensile strength, but the weakness that, in acid solution, it is subject to attack by oxidizing agents, such as ferric chloride, and like copper, is attacked by ammonia and amines. Nickel itself has been little used in the past, on account, largely, of the difficulty of working it. The metallurgical difficulties are rapidly being overcome, so the use of nickel is increasing steadily. It combines high tensile strength with high resistance to most corrosive agents, except acids under oxidizing conditions.

Construction Details

In the use of metals for the construction of apparatus to resist corrosion, it should be borne in mind that, in any electrolyte, destructive potential differences may be set up by very slight differences in composition. A welded joint, for instance, may differ enough from the main sheet to cause rapid failure. Rivets, stay-bolts, welds, etc., are therefore to be avoided unless it is definitely known that such action will not take place in the particular case in mind. In any even slightly doubtful case, the metal or metals should be tested under conditions approaching as nearly as possible those of actual use, always bearing in mind that the presence or absence of oxygen may make the difference between rapid and negligible corrosion.

The American Society for Testing Materials has published tentative methods (which are now under investigation) for the four main methods of running corrosion tests—the total immersion, the alternate immersion, the spray, and the accelerated. If the oxygen factor is carefully taken into account, the total immersion or the alternate immersion, depending on circumstances, is probably the most applicable to ordinary chemical plant work. In any case, much judgment must be used in interpreting the results. A great deal of valuable data can be found in the series of monographs issued by the National Research Council, which consists of careful abstracts of the literature, compiled by Mr. H. F. Whittaker. Unfortunately, the series is limited to only a few metals. "The Chemical Resistance of Engineering Materials," by Turner and Hamlin, also gives much valuable information on the subject and is broader in scope, while the bulletins of the concerns manufacturing the various metals contain useful data particularly as to what materials have actually been successfully handled.

Wood and Rubber

The ceramic materials, which naturally are very largely used in the chemical industry, have already been discussed.[1] Probably the next most important materials, among the non-metals, are wood and rubber. Wood possesses the advantage of cheapness and ease of working, and is fairly resistant to acids and alkalies, provided they are dilute, and also to salts. It is not adapted to the construction of pressure vessels, but is widely used for storage tanks and filter presses for acid solutions. For filter presses, where even slight corrosion would cause leakage by destroying the necessary close fit between leaves, and where the cost of special apparatus is almost prohibitive, wood is very largely used. The species of wood depends largely on the local supply and the nature of the material to be handled, but probably red-wood, cypress, and pine are the most popular. Tanks of all kinds, including storage tanks, precipitating tanks, settling tanks, etc., for handling dilute áqueous solutions, are made of wood. Lined with lead, wooden tanks are also used for sulfuric acid of higher strengths than can be handled in bare wood.

Rubber is used both in the hard and soft form. Soft rubber, for instance, makes an excellent lining for hydrochloric acid tanks, both for handling and storage. Pumps, lines, valves, fittings, etc., can be obtained in hard rubber. Either hard or soft rubber is highly resistant to aqueous solutions of acids, but is rapidly aged by oxidizing agents. Solvents, of course, must be rigidly excluded from contact with the rubber, either hard or soft.

Plastics

Another important class of materials used in the chemical plant is the plastics. Acid-proof cements, for instance, are frequently required in the assembling of apparatus. Since most alkali-resisting apparatus is built of metal, the cements and fillers are chiefly acid-resistant. Many of these have been brought out, but probably the most used are the silicate type—containing sodium silicate and a filler—and the bituminous type—containing a tar or pitch or oil and a filler. A typical cement of the silicate class contains sodium silicáte, china clay, and asbestos. It is particularly useful for strong acids and for oxidizing agents. The bituminous cements are usually some tarry or asphaltic material mixed with an acid-resistant filler, such as china-clay or barytes. Such cements usually resist dilute acids well, except nitric, and offer fair resistances to many strong acids. A mixture of litharge and glycerine is much used for miscellaneous small work, on account of the ease of making and applying. It is moderately resistant to most acids, though not exceptionally so to any one. Rubber cement is also used for special purposes and, if properly prepared and

[1] Dr. Ross C. Purdy, Secy. of American Ceramic Soc.

applied, is very useful, being resistant to both acids and alkalies in dilute solution. There are numerous other special cements that have been developed for special purposes.

Textiles

The textile materials of the chemical plant are chiefly used for filter media. Cotton, wool, hair, and asbestos are the most important members of this class. Cotton is used for general filtrations, especially for alkaline or neutral solutions, although on account of its low cost it is frequently used for acid solutions. Either wool or hair are, however, much more resistant to the action of acids than cotton, camel's hair being extensively used for this purpose. For very strongly acid media, silica, as porous blocks, is often used. Woven asbestos, which is gradually reduced to a pulp by acid, is hardly affected by alkali, and can be used as diaphragms in electrolytic caustic cells, where the conditions are extremely rigorous. Though hardly to be classed as a textile material, filter cloth made of woven wire, and very useful for many purposes, is obtainable made from a wide variety of metals.

New Anesthetic Gas Makes Good in Hospital. Propylene, one of the constituents of illuminating gas, is being used as an anesthetic in connection with major operations in a hospital in New Orleans. Dr. J. T. Halsey of Tulane University, reports satisfactory results.

This is a new step in the use of ingredients of common illuminating gas for anesthetic purposes. Ethylene, which belongs to the same chemical family tree as propylene, is already extensively used by dentists and in clinics and hospitals. But propylene is more than twice as potent, so that more oxygen can be administered with it, thus minimizing danger to the patient's breathing.

Butylene and amylene, two other members of the same family, are still more powerful, amylene having fifteen times the strength of ethylene. These two, however, are impractical for hospital use because they arouse marked nervous symptoms, which are not noted in reactions to the weaker gases.

Dr. Lloyd K. Riggs and Harold D. Goulden, of New Brunswick, N. J., who have made extensive studies of propylene with white rats, report that they have tried this gas experimentally on fifteen human subjects who volunteered for the tests.

"The higher concentrations of propylene quickly produce unconsciousness," they state. "Recovery is rapid, consciousness returns within one minute after administration of propylene is discontinued, and only one of the fifteen subjects was nauseated."

One of the two investigators allowed himself to be put under influence of propylene to the point of unconsciousness three times in one day, without any ill effects except a slight lack of coördination of his muscles which lasted for about fifteen minutes after the return of consciousness.—*Science Service*

For making coils or spirals of small-diameter brass or copper tubing, the Bureau of Standards has found that ice works satisfactorily. The tube is filled with water and then packed in salt and ice, which soon causes the water to freeze. After bending, the ice melts and runs out leaving the tube clean and empty.—*Compressed Air Magazine*

REQUIREMENTS FOR THE DOCTOR'S DEGREE IN FRANCE

ATHERTON SEIDELL, U. S. PUBLIC HEALTH SERVICE, WASHINGTON, D. C.

As compared with the definitely standardized courses leading to the doctor's degree in this and many other countries, the requirements for the degree in France are quite simple. It is necessary only that the candidate complete a given research in a manner satisfactory to the professor under whom he works. It is a kind of system of apprenticeship for research, the satisfactory completion of which is certified by the professor who recommends to the university that the degree be awarded.

Dr. W. Albert Noyes, Jr., who graduated several years ago with the degree of *doctorat d'Etat* from the University of Paris has kindly given me the following details in regard to the requirements for the doctor's degree in France.

"There are two doctor's degrees in France. The *doctorat d'université* is given by the university. In order to start work for this degree the student must satisfy the professor that he is competent to do good work and must have received two of the three certificates required for the license, or their foreign equivalent. In order to work for the *doctorat d'Etat* the candidate must have received the license (or now its foreign equivalent) by passing examinations in physics, chemistry, and mathematics. Students who start research in chemistry have, in general, received a very thorough grounding in the fundamentals of physics, mathematics, and chemistry. They may have had little or no laboratory work worth mentioning, but they are far more independent thinkers than the average B.S. in this country.

"Students for the doctor's degree do not attend regular courses unless they so desire. They are assumed to have a thorough grounding and be capable of studying by themselves. As a matter of fact most of them do visit one or two lectures a week on a special subject. In general they are a very serious lot and the professor rarely pays much attention to them after the problem is once assigned. There is little of the tendency to help the weak ones along and either the weak ones do not get through or they take many years.

"The requirements for the doctorate in France are much more flexible than in this country. There is theoretically a minimum requirement of one year, but this really means that at least one year's tuition and laboratory fees must be paid. If the professor with whom the student is working is willing to accept a given piece of research the matter is practically decided. Naturally the various professors differ considerably in the amounts they require. It is not uncommon, particularly in the natural sciences, to have theses which describe a really monumental piece of work and are as long as a text-book. In chemistry the requirements are not so severe, although I have known students to take eight or ten years to

get the degree and really work quite conscientiously most of the time. Also students frequently work two or three years on a problem only to find that the results are unsatisfactory to the professor in question. There is no feeling on the part of the university that it owes a degree to a student if he has been permitted to study several years."

In the United States and other countries, which follow more or less closely the German system, post-graduate work consists not only of directed research but also of numerous advanced courses of instruction. The candidate for a doctor's degree selects a first and a second minor in addition to his major subject. Each of these consists of regularly prescribed lecture and laboratory courses, the satisfactory completion of which is controlled by written and oral examinations. Of the three years usually required for obtaining the doctor's degree, two are devoted to the preparatory work and one to research. Thus the larger part of the student's time is occupied with lectures, laboratory courses, recitations, and examinations which differ from the usual methods of undergraduate instruction only in being more advanced. This type of post-graduate work, therefore, differs less from undergraduate work than does the post-graduate work of French universities.

Although there can be no question that the type of advanced instruction required for the doctor's degree in other countries than France is necessary, there is a question as to how much of it belongs in the undergraduate period. As mentioned by Dr. Noyes, French students who undertake post-graduate work have in general received a very thorough grounding in fundamentals of physics, mathematics, and chemistry. It is, therefore, possible for them to begin research immediately and devote their entire time to it.

It may be considered that up to a certain point in the intellectual development of individuals very close supervision of their progress is necessary. A stage is reached, however, at which divergence from standardized and definitely controlled instruction is desirable. The real question is to fix this boundary. It appears to be considered in France that when a person chooses science as a career and asks that his qualifications for this activity be examined he has reached years of discretion, and his ambition can be relied upon to make certain his further mental development. The line of demarcation between controlled instruction and independent mental cultivation is, therefore, placed at the beginning of post-graduate work and not at some point near its end.

The French system which may appear inadequate to those who are accustomed to more elaborate requirements for the doctor's degree, is evidently well suited to conditions which exist in France. It has produced many brilliant investigators and, judged on this basis, proves its worth.

The striking contrasts in the requirements for the doctor's degree, to

which attention is here called, point to the desirability of a general discussion of this subject. This might well embrace a consideration of the purposes of post-graduate work, the character of the preparation needed for a career of research, and the regulations governing the award of the doctor's degree.

Luminous Plant Gives Cold Light. Light without heat, long an ideal of scientists, is achieved by a plant which shines in the dark, the fungus known to botanists as Agaricus melleus, and sometimes found in decaying wood. This efficient organism was described in a paper presented before the Optical Society of America by Dr. W. W. Coblentz and C. W. Hughes, of the U. S. Bureau of Standards.

In the course of their study of the kind of light given out by this fungus, commonly called "fox-fire," and also that of a small shellfish called Cypridina, which likewise shines in the dark, photographs were made with a spectroscope, which analyzes the light. It was found that the illumination from the fungus was just within the limits to which the eye is sensitive. It did not contain any of the longer heat waves, or the shorter ultraviolet waves, which are present in sunlight, though they cannot be seen by the eye. The spectrum of the luminous shellfish was similar, but did not contain so much red light, while that of the firefly, it was stated, contains little blue or red, and is mostly yellowish.—*Science Service*

Makes Steel Direct from Ore. A new way of making steel and workable iron direct from the crude ore, developed recently by Henning Flodin of Stockholm, Sweden, may influence the industry and shift some of the world's iron and steel manufacturing centers. The process uses electrical power, but it will be economical only where water power for generating electricity may be cheaply obtained.

Mr. Flodin described his process to steel manufacturers and scientists at a conference held recently at Birmingham, England. He claims it has been thoroughly tested out both in the laboratory and on a large scale in the plants of the Hagfors Ironworks, in Sweden, where he has made 114 test batches of iron and steel.

He used Swedish hematite ore, English coal, and Swedish charcoal in furnaces taking from 250 to 300 kilowatts of electrical power. The process is continuous and feeding only needs to be interrupted when a batch is poured. The phosphorus and sulfur content of the product is almost negligible and carbon is as low as two hundredths of one per cent. The process is particularly well adapted to the making of high-grade tool steels.—*Science Service*

Russians Use Alcohol to Purify Aluminum Ore. Alcohol will purify half-worked aluminum ore and rid it of its troublesome iron content, according to Prof. N. Vittorf, of the Institute of Economic Mineralogy and Petrography, inventor of the process.

A common method of treatment of bauxite, the common ore, which is an oxide of aluminum, has been to treat it with sulfuric acid, converting it into aluminum sulfate. But in this treatment iron, which exists in all bauxite deposits as an impurity, stays in the treated product also as iron sulfate, which has proved to be very troublesome and difficult to get rid of.

In Prof. Vittorf's method, the aluminum sulfate is treated twice with alcohol which reduces the iron content from about three per cent to four ten-thousandths of one per cent, or virtually to nothing. This method, it is claimed, will make possible the working of bauxite beds hitherto considered of too low grade to be practicable, as well as some high-grade deposits that have a large iron content. Prof. Vittorf believes that it will be possible to apply this method on a large scale with very little loss of alcohol through evaporation.—*Science Service*

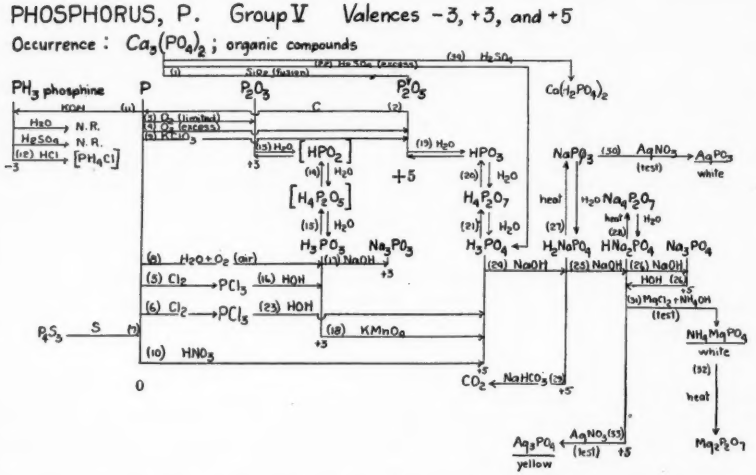
THE USE OF CHARTS IN TEACHING GENERAL CHEMISTRY

JOHN A. TIMM, YALE UNIVERSITY, NEW HAVEN, CONN.

The student, who has always been the most difficult to interest in chemistry, is the one who considers it a science containing an enormous number of isolated facts which have to be memorized. He can see no connection between these facts and is, therefore, at a loss to know how to correlate them.

Such students need all the help that can be given them and any device which shows the relationship of one fact to another and points out vividly the points of similarity and difference of the various elements, is to be welcomed.

The writer has from time to time advised students to construct charts



showing the chemical reactions of each element, studied in as brief and clear a form as possible. If the student can be made to use the same logical form in constructing each chart, the differences and similarities of the elements become apparent when their charts are compared.

The construction of such charts requires the student to reason out for himself the relationships of the various compounds of an element to one another and also necessitates his reviewing the chemical reactions of the elements previously studied in order that each new chart may take the same form.

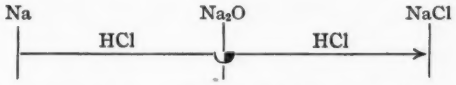
After using various methods of constructing such charts the form illustrated in the accompanying illustration was found to be one which could be adopted as a model after which to pattern the charts of the other elements.

The name and symbol of each element, its group in the periodic classification, and its valences are included in the first line of each chart. Under occurrence, on the next line, only the more important, naturally occurring compounds are placed. Their mineralogical names can be omitted, for the most part, except where they are of particular significance. Water of hydration can be treated in the same way.

The more important compounds of the element are then arranged from left to right in the order of increasing valence of the element; that is, the hydride, if it exists, is placed at the extreme left, since in it the element has a negative valence, followed by the free element with a valence of zero, and then the oxides, in which the valence is positive.

Vertical lines are then drawn down from these formulae and are considered to represent their respective formulae. An arrow pointing to a line shows a method by which the compound can be prepared, whereas an arrow pointing away from the line signifies a chemical reaction into which the compound will enter. At the lower end of each line is placed the valence of the element in the compound for which the line stands.

Whenever lines, which have no connection, cross, the convention employed by electrical draughtsmen is used. If it is desired to show, for example, that both sodium and sodium oxide can be converted into sodium chloride upon treatment with hydrochloric acid, this would be indicated as follows:



This also shows that sodium will not yield sodium oxide when treated with hydrochloric acid.

Compounds which are unstable or which have not been isolated are enclosed in brackets.

On each arrow may be placed a number which refers to an equation for the reaction represented on the chart.

After the student has constructed a series of charts they offer him a rapid method of reviewing the chemistry of any particular element.

Mining Society Medal Presented Inventor of Smoke Precipitator. Dr. Frederick Gardner Cottrell has been awarded the gold medal for 1924 of the Mining and Metallurgical Society of America. The award is in recognition of "distinguished service in the development of a method of electrical precipitation of solid and liquid particles from smelter smoke and in recognition of his public spirit in making a gift of the proceeds of his invention for the support of scientific research." Dr. Cottrell is at present director of the Fixed Nitrogen Research Laboratory of the U. S. Department of Agriculture in Washington.—*Science Service*

A TEST OF ACHIEVEMENT IN COLLEGE CHEMISTRY AND RESULTS OBTAINED BY ITS USE WITH BOTH HIGH-SCHOOL AND COLLEGE CLASSES

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Object of Test
Construction of Test
Types of Students Tested
Results of Tests
Correlation
Discussion of Results
Interpretations

Object of Test

During a study of the freshman chemistry course as generally taught in American colleges, two facts become increasingly apparent: (1) that no satisfactory objective standard exists for measuring the quality and quantity of a student's achievement in this subject, and (2) that no satisfactory proposal has been put forward for avoiding the overlapping which occurs when high-school graduates who have studied chemistry go to college and are obliged, in inorganic chemistry, to study more or less of the subject-matter over again.

The American Chemical Society not long ago appointed a Committee on Chemical Education, whose work has been directed chiefly toward securing a consensus of opinion as to what should be the content of the high-school and freshman college chemistry courses. But when syllabi for these two courses are agreed upon, there will still be some problems left, *viz.*: (1) How can we compare accurately the achievements of students whose teachers cover a definite amount of this syllabus? (2) How can we discover accurately whether this amount of subject-matter is sufficient and yet not too much for one year's work?

These problems have a direct bearing on the transfer, with credit, of students from one institution to another, and also on the admission and classification in college of high-school students who have already taken chemistry.

After study and consideration of the questions raised above, it was decided to construct a chemistry test, the primary object of which would be to measure objectively the achievement of college chemistry students at the close of a half-year's work in general chemistry. The test was administered to students in three selected colleges and for purposes of comparison, in three selected high schools.

In constructing the test, the following general test objectives were kept in mind:

1. To test the student's range of information.
2. To test the student's ability to think scientifically on problems involving chemical principles covered in the course.
3. To assist teachers in assigning course marks, since a test furnishes

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a more objective and reliable basis for judgment than is obtainable by the usual methods.

4. To assist teachers in deciding promotions and failures.

5. To enable administrators to compare the results obtained by different teachers in the same or different colleges. Correlation with Admission Intelligence Tests should assist in this comparison.

6. To assist teachers and administrators in vocational guidance work with the students.

In particular, the possible relation of the test to the problem of overlapping was kept in mind.

Construction of Test

The range of information covered by the test included the topics listed in the 1st section (Structure of Matter) of the syllabus prepared by the Committee on Chemical Education of the American Chemical Society.[1] These topics are treated by such college texts as Smith's "College Chemistry," Kendall's revision (Century, **1923**); McPherson and Henderson's "A Course in General Chemistry" (Ginn and Co.) and Deming's "General Chemistry" (Wiley, **1923**).

The test consisted of the following:

Part I	Multiple choice (5 choices)	27 items
Part II	True-False Statements	13 items
Part III	Symbols, Formulae, Equations, and Stoichiometry	53 items
	Total number of items	93

Great care was taken in the Multiple Choice part to arrange the choices so that only one was correct. The various views held by modern chemists concerning the nature of atoms, ions, electrons, isotopes, etc., made this a difficult task, and the writer is aware that the result is still imperfect.

Types of Students Tested

Table I presents in brief form the salient facts concerning the students tested in six institutions. The three colleges were all in New York City, while the three high schools were located in Ohio, Connecticut, and New York.

Results of Tests

A. Distribution.

The distribution tables prepared from the scores made by the students in the three colleges are presented in Table II, and for the three high schools in Table III.

[1] THIS JOURNAL, **1**, 87–99 (1924).

TABLE I

DATA CONCERNING STUDENTS TESTED

Colleges	No. students tested	No. of months chemistry had been studied for the average student (approximate)		Hours devoted to chemistry instruction during school year (1924–1925)	
A	106	in High School	0	lectures	2
		in College	8 (1 yr.)	quiz	1
				laboratory	3
B	79	in High School	9 (1 yr.)	lectures	3
		in College	4 (1/2 yr.)	laboratory	6
C	51	in High School	9 (1 yr.)	lectures	1
		in College	5	quiz	1
				laboratory	4
Total	236				
High schools					
D	51	in High School	5	class-room	4
				laboratory	2
E	171	in High School	6	class-room	4
				laboratory	2
F	42	in High School	4 (1/2 yr.)	class-room	3
				laboratory	4
Total	264				

Grand total of students tested....500

TABLE II

DISTRIBUTION OF SCORES OF CHEMISTRY STUDENTS OF THREE COLLEGES

Chemistry scores	College A frequency	College B frequency	College C frequency
20–22	5	..	..
23–25	1	..	..
26–28	4	..	..
29–31	8	..	..
32–34	5	..	..
35–37	12	1	..
38–40	8	..	1
41–43	14	..	0
44–46	11	2	3
47–49	16	2	2
50–52	6	3	3
53–55	6	1	3
56–58	2	4	1
59–61	1	2	8
62–64	2	10	6
65–67	1	8	12
68–70	2	4	1
71–73	2	9	5
74–76	...	10	4
77–79	...	9	0
80–82	...	7	1
83–85	...	3	..

TABLE II (*Concluded*)

Chemistry scores	College A frequency	College B frequency	College C frequency
86–88	...	3	..
89–91	...	1	..
Total cases	106	79	51

Grand total of cases for three colleges....236

A	B	C
Q_1* = 35.8	Q_1 = 63.4	Q_1 = 58.2
M = 43.1	M = 71.8	M = 62.2
Q_3 = 49.1	Q_3 = 78.1	Q_3 = 67.8

*Q_1 = 1st quartile; M = median; Q_3 = 3rd quartile in School A. This indicates that 75% of the students scored higher than 35.8; 50% scored higher than 43.1, and 25% scored higher than 49.1.

TABLE III

DISTRIBUTION OF SCORES OF CHEMISTRY STUDENTS OF THREE HIGH SCHOOLS

Chemistry scores	High school D frequency	High school E frequency	High school F frequency
11–13	..	2	..
14–16	..	3	1
17–19	..	3	1
20–22	..	5	0
23–25	..	5	4
26–28	..	9	4
29–31	..	8	1
32–34	..	10	3
35–37	..	20	3
38–40	..	14	1
41–43	..	15	4
44–46	3	16	3
47–49	6	12	2
50–52	3	16	3
53–55	6	12	2
56–58	6	6	3
59–61	6	7	3
62–64	5	3	2
65–67	5	2	2
68–70	6	1	..
71–73	1	0	..
74–76	0	1	..
77–79	2	1	..
80–82	2	0	..
Total cases	51	171	42

Grand total of cases for three high schools....264

Q_1 = 53.6	Q_1 = 34.3	Q_1 = 30.5
M = 60.2	M = 40.2	M = 43.2
Q_3 = 67.8	Q_3 = 51.5	Q_3 = 55.2

The next step was to combine the scores of the three colleges, and likewise the three high schools. The results of the two combinations of scores are set forth in Table IV.

TABLE IV

DISTRIBUTION OF SCORES OF CHEMISTRY STUDENTS OF THE COMBINED COLLEGES AND COMBINED HIGH SCHOOLS

Chemistry scores	Combined colleges frequency	Combined h. s. frequency
11–13	..	2
14–16	..	4
17–19	..	4
20–22	5	5
23–25	1	9
26–28	4	13
29–31	8	9
32–34	5	13
35–37	13	23
38–40	9	15
41–43	14	19
44–46	16	22
47–49	20	20
50–52	12	22
53–55	10	20
56–58	7	15
59–61	11	16
62–64	18	10
65–67	21	9
68–70	8	7
71–73	16	1
74–76	14	1
77–79	9	3
80–82	8	2
83–85	3	..
86–88	3	..
89–91	1	..
Total cases	236	264

Grand total of cases for combined colleges and high schools....500

$Q_1 = 43.3$	$Q_1 = 36.0$
$M = 55.4$	$M = 46.2$
$Q_3 = 68.0$	$Q_3 = 56.2$

TABLE V

MEDIANS AND QUARTILES FOR THE COLLEGES AND HIGH SCHOOLS

Colleges	No. of cases	Q_1	M	Q_2
A	106	35.8	43.1	49.1
B	79	63.4	71.8	78.1
C	51	58.2	64.2	67.8
High schools				
D	51	53.6	60.2	67.8
E	171	34.3	40.2	51.5
F	42	30.5	43.2	55.2

Correlation

In the case of College B, a study of correlation was undertaken. The correlation for the chemistry test scores and the grades given to the students for the fall semester's work was found to be 0.59, probable error ± 0.05.

The correlation between the chemistry test scores and the Thorndike Intelligence Test was also studied, and for this there was obtained a correlation of 0.42 with a probable error of ± 0.06.

Discussion of Results

The differing results of the scores of the three colleges were due to a number of factors, chief among these being previous chemical preparation, time alloted to instruction in college, type of instruction, and whether or not the students were highly selected on the basis of ability.

Table IV shows that the difference between these high-school and college students in ability to do these tasks is not large. It shows that more than 25 per cent of the high-school students excelled the score of the median student in the colleges.

The correlation between the chemistry scores and the semester grades shows that there is a rather definite relationship between the scores and the factors which go to make up the semester grades.

The correlation between the chemistry scores and the Thorndike Intelligence Test does not indicate a marked relationship.

With due allowance for differences in the ground covered in the courses taken by the students who were tested, the data support the conclusion that the content of the courses for the high-school and freshman college students of chemistry should be selected on basis of needs rather than on differences in ability of the two groups, for the ability of the best high-school and the best college students must be nearly the same. With reference to this, it should be remembered that the achievement in High School D (median = 60.2) is the result of six forty-five minute periods per week, while College B students (median = 71.8) had nine one-hour periods per week, and every student had had a preparatory year of high-school chemistry. Moreover the selective factor in College B is such that only the most intelligent students are admitted to the course.

Interpretations

The problems which have been attacked in this preliminary study are so important that the work here reported can be regarded as scarcely more than a beginning. This study of the 500 cases is inadequate for generalizations and there is need for further study of the differences between high-school and college students in ability to master subject-matter. The study should be extended in each of several universities where coöpera-

tion between the departments of chemistry and education is feasible. The information gathered from such a study would aid materially in the interpretation of problems relating to the correlation of high-school and college chemistry. Furthermore, a standardized freshman chemistry test would be a by-product.

The need for a test for high-school chemistry does not exist as we already have the standardized tests of Gerry, Powers, Rich, and others.

It is not proposed that standardized tests for college freshmen like the one used in this investigation should supplant regular examinations, but rather that the tests should be supplementary. Their use would make the measurement of the student's achievement more reliable. But of greater significance is the fact that their use would help to define the field which belongs to the high school and the field which belongs to the college.

The writer desires to express his thanks to Professor S. R. Powers of Teachers College under whose direction the work was carried out, to Professors C. D. Carpenter, Victor La Mer and Ben D. Woods of Columbia, to Mr. W. W. Carpenter, and to the several teachers in the high schools and colleges without whose coöperation the work could not have been carried through.

TEA EXAMINER

Receipt of applications for tea examiner will close January 30th. The date for assembling of competitors will be stated on the admission cards sent applicants after the close of receipt of applications.

The examination is to fill vacancies in the Bureau of Chemistry, Department of Agriculture, for duty in the field.

The entrance salary is $2400 a year. After the probational period of six months required by the civil service act and rules, advancement in pay may be made without change in assignment up to $3000 a year. Promotion to higher grades may be made in accordance with the civil service rules as vacancies occur.

The duties are to have charge of a tea-examining station, and to test all samples of teas for purity, quality, and fitness for consumption in comparison with the physical standards of purity, quality, and fitness for consumption established by the Department of Agriculture, and to attend to all of the administrative work in connection with a tea-examining station.

Competitors will be rated on practical questions on the tea trade and the tea law; practical tests covering kinds, quality, and character of teas; a thesis to be submitted to the examiner on the day of the examination; and on education and experience.

Full information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or the secretary of the board of U. S. civil-service examiners at the postoffice or customhouse, any city.

DOCTORATES IN CHEMISTRY CONFERRED BY AMERICAN UNIVERSITIES

1922–23, 1923–24, 1924–25

COMPILED BY

CALLIE HULL AND CLARENCE J. WEST, RESEARCH INFORMATION SERVICE, NATIONAL RESEARCH COUNCIL, WASHINGTON, D. C.

The Research Information Service of the National Research Council, through the courtesy of the various American universities granting the doctor's degree, has compiled annually since 1919–20 a classified list of the theses of the recipients of this degree in the sciences, with a table showing the comparative statistics for the last 10 years. (From 1921–22 through 1922–23 the data for the arts were included, but dropped in 1923–24 as too voluminous a compilation of material and as outside the scope of the Council's activities.)

The compilations for the first three years were published;[1] but since 1923 the amount of space required has prevented the printing of them. These data, however, are available at the Research Information Service, and information concerning them will be furnished on request.

From the three unpublished compilations, 1922–23 to 1924–25, the data for Chemistry have been extracted. It should be noted that the numbers given in the following tables will not always agree with those to appear soon in *Science*,[2] as some of the dissertations in related fields of interest to chemists have been included here, while in the other table they have been left according to the subject indicated by the university.

Table I gives the statistics for chemistry by university, by year. While the compilation was made annually from 1898 to 1916 by other agencies, and the statistical data for 1917 and 1918 were filled in by questionnaires from the Research Information Service, no information as to the distribution by subject, by university, is available prior to 1919. Table I, therefore, begins with that year.

Table II shows the number of doctorates conferred in chemistry as against the total number conferred in all other sciences during the last 25 years.

Table III shows the doctorates conferred in chemistry during the past five years by the ten universities granting ten or more doctorates in this science in 1925, illustrating the striking growth of the work during this time.

A list of the theses presented by the recipients, by university, by year, is appended. The Research Information Service has found this

[1] *Science*, **52**, 478–83, 514–7 (1920); **55**, 271–9 (1922); *School and Society*, **17**, 57–63, 106–9, 132–9 (1923).

[2] *Science*, **62**, 578–9 (1925).

list a suggestive guide to the research which is being done, to the universities at which the work is being carried on, and to the persons interested in special fields.

TABLE I

DISTRIBUTION OF DOCTORATES IN CHEMISTRY BY UNIVERSITY, BY YEAR

	19–20	20–21	21–22	22–23	23–24	24–25
Boston	..	..	..	1	..	..
Brown	1	1	..	..	..	5
Bryn Mawr	..	..	1	..	..	..
California	3	6	8	11	6	8
Catholic	..	..	..	1	2	2
Chicago	13	16	14	12	19	14
Cincinnati	1	2	3	1	2	4
Clark	2	3	2	3	3	..
Colorado	..	..	1	1	..	1
Columbia	8	18	13	28	35	30
Cornell	3	8	9	8	19	14
George Washington	3	1	..	6	3	1
Harvard	4	5	3	5	18	13
Illinois	8	7	16	19	19	18
Indiana	..	..	1	2	1	2
Iowa	..	..	..	4	3	6
Iowa State	..	..	..	..	4	7
Johns Hopkins	10	10	13	12	12	10
Kansas	..	..	..	..	1	3
Mass. Agric. College	..	..	..	1	..	..
Mass. Inst. Tech	4	6	5	6	11	17
Michigan	2	6	5	2	11	2
Minnesota	..	..	5	3	9	8
Missouri	..	..	..	..	1	1
Nebraska	..	1	1	1	3	3
New York	1	3	1	6	1	3
North Carolina	..	2	1	1	..	..
Northwestern	..	..	4	..	4	1
Notre Dame	..	..	..	..	1	..
Ohio State	2	5	4	13	14	23
Pennsylvania	..	1	3	..	4	1
Pittsburgh	1	2	5	6	5	7
Princeton	3	5	5	2	8	4
Radcliffe	..	1	..	..	..	..
Stanford	..	2	1	3	8	2
Virginia	1	..	1	1	2	3
Washington Univ. St. L.	..	..	..	1	..	..
Washington	..	1	2	..	1	2
Wisconsin	8	9	13	14	21	26
Yale	12	13	13	17	8	16
Total	90	134	153	191	259	257

TABLE II

Year	Chemistry	Total	Year	Chemistry	Total
1900	26	102	1913	68	234
1901	28	127	1914	71	244
1902	27	103	1915	86	314
1903	33	134	1916	115	336
1904	35	129	1917	108	372
1905	36	143	1918	75	293
1906	38	140	1919	54	180
1907	38	143	1920	90	325
1908	54	184	1921	134	334
1909	43	194	1922	153	442
1910	48	180	1923	191	572
1911	68	239	1924	259	597
1912	78	273	1925	267	621

TABLE III

	1920	1921	1922	1923	1924	1925
Columbia	8	18	13	28	35	30
Wisconsin	8	9	13	14	21	26
Ohio State	2	5	4	13	14	23
Illinois	8	7	16	19	19	18
Mass. Inst. Tech	4	6	5	6	11	17
Yale	12	13	13	17	8	16
Chicago	13	16	14	12	19	14
Cornell	3	8	9	8	19	14
Harvard	4	5	3	5	18	13
Johns Hopkins	10	10	13	12	12	10

Boston

1922–1923: Edward Parkhurst Phelps, "Study of peroxide and aldehyde as contaminants of anesthesia ether."

Brown

1924–1925: Ralph Hadley Bullard, "A study of some reactions and properties of the trimethyl stannyl group and its derivatives." Wayland McColley Burgess, "A study of some properties of lithium chlorate and of homogeneous mixtures of this salt with water." Warren Charles Johnson, "Properties of metals and metallic compounds in ammonia and amines." Philip Carl Scherer, Jr., "A study of some phenyl tin compounds." Ralph Pray Seward, "Solubilities of salts in the presence of other salts in non-aqueous solvents."

California

1922–1923: Hal Daniel Draper, "Pore volume of the catalysts manganese dioxide, copper oxide, and mixtures of these oxides." Robert Montgomery Evans, "Equilibria in the systems iron: hydrogen: oxygen and iron: carbon: oxygen." George Glockler, "Critical and dissociation potentials of hydrogen." William Muriece Hoskins, "Absorption of gases by the catalysts manganese dioxide, cupric oxide, and mixtures of these oxides." Harry Karl Ihrig, "Asymmetric dyes." William Douglas Ramage, "Differential method for the determination of partial molal heat capacities and specific heats of dilute solutions." Gerhard Krohn Rollefson, "Spectral series in the soft X-ray region." Henry Herman Storch, "Synthesis

of ammonia from its elements in the low-voltage arc." Nelson Woodsworth Taylor, "Activities of zinc, cadmium, tin, lead, and bismuth in their binary liquid mixtures." Harold Clayton Urey, "Statistical distribution of the electron in the quantum states of the hydrogen atom. Heat capacities and entropies of diatomic and polyatomic gases." Thomas Fraser Young, "Effect of surface charges in vacuum discharge tubes."

1923–1924: Ralph Mulvaney Buffington, "The shape of the coefficient of expansion curve of solids at low temperatures." Grenville Barker Frost, "I. Sulfur dioxide as an analytical standard in acidimetry and iodimetry. II. The heat of formation of sulfur dioxide and sulfuric acid." David Morris Greenberg, "Studies on the formation and ionization of the compounds of casein with alkalies." James Blaine Ramsay, "I. The iodimetric determination of vanadium. II. The simultaneous reduction of vanadic acid and oxygen by iodide, and by sulfurous acid." Joseph Simons, "Studies upon fluorine and certain fluorides: (*a*) the preparation of fluorine, anhydrous hydrofluoric acid, and carbon tetrafluoride; (*b*) the freezing points and the pressure-temperature diagrams for hydrofluoric acid and for carbon tetrafluoride; (*c*) attempts to prepare a fluocarbonate, and their bearing upon the valence of carbon." Albert Percival Vanselow, "Acidity coefficients of dilute aqueous electrolytes."

1924–1925: James Luther Brakefield, "Studies on the syntheses and elimination of certain bile components in obstructive jaundice." Gerald Frederick Breckenridge, "Electromotive force measurements in hydrochloric acid solutions and the principle of the ionic strength." Howard Domer Hoenshel, "The specific heats of lead bromide and bromine, and the entropy of bromine." Carl Iddings, "The absorption spectrum and the photochemical decomposition of gaseous acetone." Robert Stanley Livingston, "The activity of hydrobromic and hydrochloric acids and their catalytic action in the decomposition of hydrogen peroxide." Clive Maine McCay, "Studies in the synthesis and chemical properties of proline and related compounds." Herman Carl Ramsperger, "The photochemical decomposition of formic acid vapor." George Cornelius Ruhle, "The free energy of dilution of molten lead halides." Hugh Miller Spencer, "The free energies of some lead compounds."

Catholic

1922–1923: Henry Peter Ward, "Action of hot calcium carbide on the vapors of monohydric aliphatic alcohols."

1923–1924: Eugene Patrick Mullins, "The catalytic hydrogenation of the condensation products of acetone." Joseph Bailey Tomlinson, "The activity coefficients of hydrochloric acid in the presence of magnesium sulfate and lanthanum chloride."

1924–1925: Christopher Marzano, "Titania jellies." William Richard Sheridan, "The hydrogenation of some condensation products of acetone."

Chicago

1922–1923: Lyman Chalkley, Jr., "Mercurization of methylene blue. Mercurization of some substituted phenylammonium salts and anilines. Nitrobenzene mercury compounds, an indirect method of mercurizing organic compounds." Quaesita Cromwell Drake, "An investigation of the possibility of rearranging an acyl-beta-alkylhydroxyamine." Marie Dye, "Basal metabolism of normal women and its relation to creatine and creatinine elimination." Earl C. Gilbert, "Molecular rearrangements of hydrazine derivatives. IV. Rearrangement of benzoylhydrazine, di-benzoylhydrazine, and azodibenzoyl." Arthur Preston Locke, "Arsenical de-

rivatives of phenylacetic acid, with a discussion of a theory of diazotization and of syntheses by means of diazo compounds. Potentiometric estimation of arylamines." Archibald Turner McPherson, "Electromerism of bromine chloride." Samuel Leo Madorsky, "Separation of mercury into isotopes in a large apparatus. Graphical study of the stability relations of *Atom Nuclei*." William Lamkin Ray, "Positive iodine in iodomesitylene. Positive bromine and iodine in derivatives of paranitraniline and of paraphenylenediamine." Herman Bernhard Siems, "Determination of the equilibrium relation between manganates and permanganates under varying hydroxyl ion concentration." Julian Francis Smith, "Rearrangements of hydrazine derivatives. III. Rearrangement of triphenyl-methyl-hydrazine and of benzophenone hydrazone." Frederick Walter Stavely, "On the behavior of mercuric salts of organic acids toward heat." James Kidder Stewart, "Molecular rearrangement of diphenylmonobiphenylmethylchloroamine."

1923–1924: Samuel King Allison, "Atomic stability. III. The effects of electrical discharges and high temperatures." William Clardy Austin, "Phospholipins in yeast." Theodore Elliott Boyd, "The influence of alkalies on the secretion and composition of gastric juice." Charles Neil Cameron, "The preparation of optically active hydrazines. III. The preparation of *p*-'Active amyl'-phenylhydrazine." Marion Gabriel Frank, "Experiments to prepare mercurized derivatives of methylene blue." Leslie Hellerman, "A study of the molecular rearrangements of halogenamine derivatives in anhydrous media." Ida Kraus, "Colorimetric determination of tryptophane by the vanillin-HCl reaction and the quantitative separation from indol and skatol." Margarete Meta Hedwig Kunde, "The after effects of prolonged fasting on the basal metabolic rate." Laura Ida McLaughlin, "Urinary excretion of organic acids and its variation on different diets, with observations on the creatinine excretion of women." Howard Roswald Moore, "The photochemical activation of a mercury surface. A possible relation between photoelectric effect and photochemical action." Eloise Parsons, "Histamine as a constituent of secretin preparations." John Richard Sampey, Jr., "Positive halogens: 4-iodometaphenylenediamine and 4-iodoresorcinol." Reuben Benjamin Sandin, "Positive halogens in derivatives of 2-iodo-4-aminotoluene." Hayward Merriam Severance, "Nitration of benzoic acid in acetic acid solution." Leo Prentiss Sherman, "The C_4-saccharinic acids. III. The preparation of *dl-1,2*-dihydroxy-isobutyric acid and a study of some of the derivatives." Mary Lura Sherrill, "I. The reaction of bromo-nitro-methane with aromatic compounds in the presence of aluminium chloride—a case of electro-electromerism acid. II. The preparation of pure methylene-di-salicylic." Mark Watkins Tapley, "The absorption spectra of halogenoplatinates. A method of preparation of the double fluorides of the platinum group metals." Jennie Tilt, "Observation on the basal metabolism and urinary creatinine, creatine, and uric acid of school children." Edward Staunton West, "The molecular rearrangement of symmetrical bis-triphenylmethylhydrazine and triphenylmethylhydrazine."

1924–1925: Louis Jacob Bircher, "Different types of overvoltage and the temperature effect. The effect of pressure on overvoltage." Edward Donald Campbell, "Benzol condensation products of creatinines." Chang Kong Chuang, "Stereoisomeric hydrazones $RR'C:N.NH_2$." John Willard Hershey, "I. Transference numbers of the formates of sodium, potassium and lithium in anhydrous formic acid. II. The effect of salts upon the solubility of other salts—The solubility of uni-univalent salts in solution of uni-univalent salts." Harris Hazen Hopkins, "The optically active acid chlorides." Harry Victor Hume, "Positive halogens: 2- and 3-iodo-4-methylphenyltrimethyl ammonium chlorides." Barclay Lincoln

Jones, "Derivatives of Nile Blue A. On the mercurization of Nile Blue A." Ernest Baker Keith, "A theory of emulsions as produced by films of oriented molecules." Margaret Willcox McPherson, "Derivatives of phenylbutyric acid." Karl Stone Means, "A study of the velocity coefficient of the saponification of ethyl formate." Roy Chester Newton, "Interhalogen replacement in halogeno-acetone." Donald Raymond Stevens, "Alcoholysis and hydrolysis of alkyl halides." Francis Henry Thurber, "The optically active *p*-trimethylethyl-phenyl-hydrazines. The usefulness of these compounds as resolving agents." Henrietta Lydia Zollman, "I. Interfacial tension and emulsification and extremely small interfacial tensions. II. The electron affinity of iodine and bromine."

Cincinnati

1922–1923: Moses Legis Isaacs, "Biochemistry of silicon with a quantitative method for its determination in tissue."

1923–1924: Walter Andrew Cook, "Some hydroxyurethanes and the silver salts of their acyl derivatives." John Henry Foulger, "The action of formaldehyde upon blood serum."

1924–1925: Wyly McGehee Billing, "The action of the toxin of *Crotalus adamanteus* on blood." George Magee Enos, "Fundamental factors in corrosion." Irvine Walter Grote, "A standardization of the Sandmeyer reaction with special applications." Paul Elmer Wedgewood, "The relation of vitamins to anaphylaxis and immunity."

Clark

1922–1923: Raphael Rosen, "Study of the properties of some compounds of the triphenyl methyl and triphenyl silicyl groups." Allen Byron Stowe, "Influence of salts on the solubility of other salts in non-aqueous solvents." Earle Forrester Whyte, "Study of the oxides of sodium and potassium."

1923–1924: George Fletcher DesAutels, "The conductance of dilute aqueous solutions in certain acids." Willard N. Greer, "A study of the dimethyl tin group." William Vyne Sessions, "A study of the trimethyl tin group."

Colorado

1922–1923: Malcolm Cleveland Hylan, "Adsorption in photography."

1924–1925: Marion Scott Carpenter, "The condensation of mesityl oxide with aliphatic ketones."

Columbia

1922–1923: Lillian Eloise Baker, "Effect of substitution on the free energy of reduction of benzoquinone." Grover Bloomfield, "Some characteristics of invertase action and their significance in interpreting the nature of the reaction." Stephen Patrick Burke, "Hydrolysis of methyl chloride." Donald H. Cook, "Temperature coefficients of enzymic activity and the heat destruction of pancreatic and malt amylases." Eugene D. Crittenden, "Compound formation, solubility and ionization in fused salt mixtures." Leo Patrick Curtin, "Relation between molecular structure and odor in tri-substituted benzenes." Harriet Isabel Edgeworth, "Experiments with two methods for the study of vitamin B." Rocco Fanelli, "Volumetric determination of arsenic acid." Ralph Talbot Goodwin, "Organic content of oil shales." Merritt Roy Grose, "Quantitative study of the heat destruction of vitamin B." Louis Plack Hammett, "Experimental studies on the hydrogen electrode." Waldemar Conrad Hansen, "Hydration of normal sodium

pyrophosphate to orthophosphate in varying concentrations of hydrogen ion at forty-five degrees centigrade." Pilar Perez Herrera, "Synthesis of di-aryl selenophenes, and related compounds." Eric Randolph Jette, "Study of the vapor pressures of certain hydrated metallic sulfates." Lucille Johnson, "Mechanism of the mutual precipitation of hydrosols." Margaret W. Kelly, "Fixation of vegetable tannin by hide substance." Martha Morrison Kramer, "Experiments on vitamin A." Gustav Ernest Landt, "Influence of alpha-methyl glucoside in the invertase hydrolysis of sucrose." Vincente Gregorio Lava, "Photo-chemical studies." Malvin Robert Mandelbaum, "Action of sulfur on *p*-toluidine in the presence of litharge; thio-*p*-toluidine; its structure and some new derivatives." Henry Keppele Miller, Jr., "Compound formation, solubility and ionization in fused salt mixtures." Lewis Benjamin Miller, "Influence of certain electrolytes on the composition of saturated Bredig gold sols." Nellie May Naylor, "Influence of some organic compounds upon the hydrolysis of starch by salivary and pancreatic amylases." Harold Eugene Robertson, "Are electrolytes completely ionized at infinite dilution?" Victor Ross, "On the mode of action of pepsin with special emphasis on the influence of the concentration of the *Intermediate product* on the velocity of digestion." Aaron Ruderman, "Some new condensations with *p,p*-bis-(dimethylamino)-benzhydrol (Michler's hydrol)." Frank Leslie Seymour-Jones, "Hydrolysis of collagen by trypsin." Adelaide Albertine Spohn, "Critical investigation and an application of the rat growth method for the study of vitamin B."

1923–1924: Isaac Bencowitz, "Compound formation, specific conductivity, and ionization in fused salt mixtures." Frank H. Bergeim, "Columbia Yellow. Its structure and related intermediates." Lyman Crowell Boynton, "Quantitative experiments upon the occurrence of vitamin A in the body, and the influence of the food." Leo Wendell Briggs, "The growth of colloidal gold particles formed by the Bredig method in aqueous solutions of barium chloride." Moses Chertcoff, "A new group of dyes from poison gases through the 2-aminothiazoles as intermediates." Helen Clark, "Stereoisomeric styryl derivatives of some 4-quinazolone alkyl iodides and their bearing upon the problem of photosensitizing dyes." David Josaphat Cohn, "Invertase in honey." Paul Ballinger Davidson, "The stability of Bredig gold sols." Alexander Frieden, "Ferric oxide hydrosol." Malcolm Morrison Haring, "The separation of the isotopes of mercury by electrolysis." Franklin Hollander, "Uniformity in invertase action. II." Horace Herbert Hopkins, "The action of sulfur and selenium on 6-benzalamino-2-phenyl benzoselenazole. Synthesis of an analog of cinchophen." Aleita Hopping, "Seasonal changes in the gases and sugar of the blood and the nitrogen distribution in the blood and urine of the alligator." Konrad Chang Hsu, "A quantitative study of destruction of vitamin A in butter fat by heating." Ralph Waldo Kerr, "Uniformity in invertase action; the influence of accompanying material on the stability of the enzyme." Moses Kunitz, "Valency rule and alleged Hofmeister series in the colloidal behavior of proteins." Olive M. Lammert, "The conductance of and the effect of light radiations on solutions of the alkali halides in acetophenone." Ernest Little, "The determination of the acidity of a tan liquor." Florence Louise MacLeod, "Fat-soluble vitamin and calcium in nutrition." Grace MacLeod, "Studies of the normal basal energy requirement." David Percy Morgan, Jr., "Collodion membranes of high permeability." Hazel Edith Munsell, "The quantitative determination of relative amounts of vitamin A." Cecil Dunmore Murray, "The acid-base equilibrium in simple two-phase systems." Fred Paul Nabenhauser, "I. Phthalone formation in the quinazoline series. II. 2-Phenyl-quinazoline-4-carboxylic acid, a quinazoline analogue of atophan and some other new quinazoline derivatives." Philip Samuel Nisson, "Derivatives of terephthalic acid." Louis Pine,

"A study of the acid soluble phosphoric acid in eggs." Edward Mark Slocum, "The reactions of the polymethylene derivatives in the preparation of higher olefine primary alcohols." Foster Dee Snell, "Methods of preparation of dehydro-thio-*p*-toluidine and 2-(*p*-amino phenyl) benzothiazole; a study of some derivatives of the former." Mortimer J. Stammelman, "The measurement of the activity coefficients of certain acids over a wide range of concentration." Lillian Boynton Storms, "Further experiments on vitamin A." Hans Walter Vahlteich, "A study of the action of trypsin on casein." George Henry Walden, Jr., "An improved method for measuring the electromotive force of cells with high internal resistance; applications to the silver nitrate concentration cell." San Yin Wong, "Micro methods for the determination of proteins and sugars in biological mixtures." Ella Woods, "The determination of cystine by means of feeding experiments." William Archer Worsham, Jr., "A study of the stability of magnesium ammonium phosphate ($MgNH_4PO_46H_2O$) and a method of determining phosphorus as magnesium ammonium phosphate ($MgNH_4PO_46H_2O$)."

1924–1925: Carl Norman Andersen, "2,4-diphenylselenophene, its derivatives and related compounds. A new synthesis of 2-phenylbenzoselenazole from orthonitrochlorobenzene." Joseph Albert Babor, "Concentrating dilute nitric acid." Mary Baeyertz, "A study of Bredig platinum sols." Howard Leonard Bender, "Phenol resins and resinoids." Oscar Bodansky, "Mutarotation as a factor in the kinetics of invertase action." Georgia Winifred Burton, "Effect of hydrogen ion concentration upon the destruction of vitamin B by heat." Donald Elmer Cable, "A liquid sulfur dioxide process for sulfite pulp." Margaret L. Cammack, "A quantitative study of the storage of vitamin A." Beverly Leonidas Clarke, "The application of the moving boundary method in the separation of certain rare earths." Arnold Miller Collins, "The electrolytic introduction of alkyl groups." Hugh Blake Corbitt, "Investigations in the 2-phenyl-benzothiazole groups with special reference to the arsenic derivatives." Ralph Liggett Evans, "I. A preliminary investigation of the chlorination of toluene. II. Diamins and nitramins diaryl ether and certain of their derivatives." Wida Gegenheimer, "Studies on the quantitative estimation of the cystine content of casein." Paul McHeehan Horton, "Gold adsorption by alkaline charcoal." James Masanaga Inouye, "Studies of salivary mucin and its quantitative determination." Cecil V. King, "The mechanism of acid catalysis of ester hydrolysis." Morris Mattikow, "A direct identification of rapeseed oil." Earl Ralph Norris, "The irregular series in the precipitation of albumin." Charles Irwin Post, "Hydrolysis of sucrose by invertase in the presence of alpha methyl glucoside." Edmond John Quinn, "The relative thermostability of vitamin A." George Garfield Ramsey, "Temperature coefficients of enzymic activity and the heat destruction of trypsin." John Joseph Ritter, "The constitution of the so-called 'Pechmann dyes,' the mechanism of their formation from beta-benzoyl acrylic acid, and some further studies in the benzoyl acrylic ser." Carroll Morgan Salls, "Sulfuryl chloride manufacture and uses." Murray J. Shear, "The composition of Bredig gold sols." Leonard Smidth, "The action of sulfur on *p*-toluidine: some new derivatives of thio- and dithio-*p*-toluidine." Constantine Theodore Sottery, "The study of the accelerating effect of glucose on invertase from honey." Arthur Stull, "Preparation of new benzothiazoles acid anhydride and acid chloride derivatives of di-*o*-amino-phenyl disulfide." Ione Weber, "On nucleosidases." James Frederick White, "The development of the moving boundary method for the separation of mixtures of electrolytes, and a consideration of its applicability to the separation of isotopes." William John Youden, Jr., "A new method for the gravimetric determination of zirconium."

Cornell

1922–1923: Arthur John Rider, "Study of the hydrogen electrode with special attention to its application in determining the acidity of various types of milk." Gilbert Brown Lorenzo Smith, "Some reactions of carbon disulfide." Nathan Frank Blau, "Occurrence and significance of amino-acid and peptid nitrogen in human blood." Paul Andrew Downs, "Study of the organisms causing thickening in sweetened condensed milk." Emil Kline, "2,3-Dihydroxybenzoylobenzoic acid and some of its derivatives." Asa Emanuel McKinney, "Behavior of anhydrous hydronitric acid towards various inorganic salts." Vartkes Migrdichian, "Study of the dissociation of ammonium carbonate from the standpoint of the law of mass action 10–45°." Lowell Haines Milligan, "Quantitative determination of reduction products of free nitric acid solutions."

1923–1924: Willard Riehlman Barrett, "Isophenolphthalein and some of its derivatives." Meyer Bodansky, "Experimental studies on liver injury and on anemia." Harold Duke Brown, "Sulfofication in pure and mixed cultures with special reference to sulfate production, hydrogen-ion concentration and nitrification." Robert Brainard Corey, "The hydrides of germanium." Frank Anton Csonka, "On the administration of various proteins, with benzoic acid, to a pig." Arnold John Currier, "Absorption of carbon disulfide vapor by aqueous sodium trinitride solutions—applications to gas analysis." Walter Sprague Frost, "A study of ammonium trinitride." Edgar Blauvelt Johnson, "A method for the extraction of germanium from germanium-bearing zinc oxide." James Arthur Kennedy, "A study of the method for the determination of oxygen consumed water." Thomas Tien-Gi Ling, "A study of the oxidation of Chinese wood oil." Alton LeFevre Markley, "A chemical and physico-chemical study of the composition of milk with special reference to the original acidity." Clyde Walter Mason, "Microscopic chemical reactions of the acids of chlorine, bromine and iodine." Sarah Alice McNulty, "Orthocresolbenzein and some of its derivatives." Alden Howard Moody, "The quantitative separation of thorium and cerium." Roy Wallace Moore, "The hydrides of germanium." Leo Chandler Norris, "The volatile fatty acid production in the intestinal tract of calves fed whole milk or cereal gruel." Alvin Canfield Purdy, "Metacresolsulfonephthalein and 3,6-dimethylsulfonefluoran and some of their derivatives." Richard Shepard Vose, "Sulfonefluorescein and dihydroxybenzoylbenzene-O-sulfonic acid and some of their derivatives." Frank Wilcoxon, "The ammonalysis of sodium nitrate."

1924–1925: Raymond William Bell, "The effect of heat on the solubility of the calcium and phosphorus compounds of milk." George Henry Brandes, "Studies on indicators, neutralization and hydrogen-ion concentration." Ralph Thomas Kline Cornwell, "Thymolsulfonephthalein, the intermediate acid, 4¹-hydroxy-3¹-isopropyl-6¹-methyl-benzoyl-2-benzene sulfonic acid and some of their derivatives." Lauchlin MacLaurin Currie, "Antimony sulfides." Paul Henry Fall, "The detergent action of soaps." John Sutliff Fonda, "Factors determining the whiteness and opacity of white paint." Nathaniel Fuchs, "Pyrogallolsulfonephthalein, 2,3,4-trihydroxy-benzoyl-benzene-*o*-sulfonic acid, the intermediate acid, and some of their derivatives." Viola Arvin Graham, "Experimental proof of the protein nature of urease." Charles Abel Gurchot, "Permeability of membranes." Francis Evaul Hance, "Metallic germanium." Andrew Joseph Hemmer, "Fluorescein and some of its derivatives." Freeman Smith Howlett, "The nitrogen and carbohydrate composition of the developing flowers and young fruits of the apple." Josephine Overton Souders, "Some studies on the corrosion of metals." Paul Warttman, "The reaction between sulfur trioxide and hydrogen cyanide."

George Washington

1922–1923: Myron Salle Anderson, "Absorption by colloidal and non-colloidal soil constituents." Edward Lawrence Griffin, "Properties of emulsions of mineral oil with soap and water." Joseph Hyram Roe, "Estimation of hydrocyanic acid and simple soluble cyanides." Albert Ronald Merz, "Recovery of potash as a by-product in the blast-furnace industry." Max Phillips, "Synthesis of thymol from para-cymene." Augustin Mitchell Prentiss, "Specific heat and thermal diffusivity of certain explosives."

1923–1924: Ruth Buchanan, "The analysis of noodles of known composition and the estimation of egg solid content, from the analyses." Ernest William Guernsey, "The mechanism of the formation of sodium cyanide from carbonate, carbon and nitrogen." James Clyde Munch, "Distribution coefficients and pharmacological action in homologous series."

1924–1925: Bonifant Hamilton, "A contribution to the knowledge of blood chemistry in infections and anaphylactic states."

Harvard

1922–1923: Gerald Ruggles Barrett, "Isoxazoline oxides. Some addition reactions of phenyl benzoyl acetylene." Fred Reece Griffith, Jr., "Nervous and hormone control of the blood sugar." Ansel McBryde Kinney, "Catalytic reduction of α,β-unsaturated compounds. Addition of phosphorus trichloride to saturated aldehydes and ketones." Dai-Chin Lee, "Mechanical properties of iron and steel and some other metallic alloys at various temperatures and their relations to the thermal critical ranges. The dendritic structure of metallic alloys." Edouard Philippe Raphael Saerens, "Compressibilities of simple salts. Oxidation of cyanimides."

1923–1924: Charles Francis Hitchcock Allen, "Some delta ketonic nitriles and their relation to cyclic compounds." Paul Allen, Jr., "I. Some addition reactions of α,β-unsaturated ketones. II. Nitro cyclopropanes containing tertiary nitro groups." Harris Marshall Chadwell, "Water: A contribution to the study of its molecular constitution." Albert Sprague Coolidge, "The adsorption of vapors by charcoal." Ben Bennett Corson, "The mechanism of the reaction between aldehydes or ketones and substances containing active hydrogen." Charles Stephen Dewey, "I. Gamma nitro-ketones. Isoxazoles from benzoyl acrylic ester. II. Some addition reactions of pentadieneones." Ralph Laurence Dodge, "I. The analysis of hydrogen for traces of nitrogen. II. The ammonia equilibrium, with a bibliography of ammonia." Mark Reuben Everett, "I. The estimation of small amounts of potassium. II. Acid-soluble organic phosphorus in blood." Louis Frederick Fieser, "Reduction potentials of quinones." Ernest Lee Jackson, "I. Addition reactions of the hypohalogen acids and their esters. II. A study of β-bromophosphonic acids." Walter Raymond Kirner, "The relationship between the structure of certain organic chlorides and the rate of their reaction with potassium iodide." Kuo-Hao Lin, "The determination of chloride in urine and blood." Charles Doak Lowry, Jr., "I. Some new derivatives of phenoxarsin. II. The alkylation of a delta-ketonic nitrile and corresponding pyridine derivatives." William Theodore Richards, "Studies in atomic and molecular interaction." Arthur Ferdinand Scott, "The atomic weight of boron." Edward Wheeler Scripture, Jr., "The atomic weights of silicon and arsenic." Walter Elwood Vail, "I. The catalytic poisoning of hopcalite. II. An isoxazoline oxide. III. The behavior of tungsten incandescent lamps containing carbon monoxide." Samuel Wilson, "I. An equilibrium in the cobaltamines. II.

The effect of surface orientation on reaction velocity. III. Polymorphic transformations of antimony sulfide."

1924–1925: Paul Alexander Anderson, "I. The electrochemical behavior of liquid barium amalgams. II. The activity of hydrogen desorbed from platinum and palladium." Sidney William Bliss, "Ammonia formation in the animal organism." Oscar Cleon Bridgman, "I. A standard 4° interval of temperature. II. Heats of hydrolysis of certain esters." Frederic Raymond Butler, "Factors limiting 1,6 addition." Harold Bangs Cutter, "I. The reduction of carbonyl compounds in homogeneous media. II. Reduction potentials and irreversible catalytic hydrogeneration. III. Experiments with 1,6 diketones." Barnett Fredericus Dodge, "Phase equilibrium relations for the oxygen-nitrogen binary system at low temperatures." Hans Christian Duus, "Heats of esterification; studies in slow calorimetry." Tadayoshi Fuiihara, "Corrosion of iron and steel." Frank Thomson Gucker, Jr., "An improved differential method for the exact determination of specific heats of aqueous solutions." Lawrence Persival Hall, "I. The potential between bivalent and tervalent titanium chloride on a mercury electrode. II. The atomic weight of lead from specimens resulting from an attempted separation of lead into its isotopes." Ralph William Helmkamp, "I. The addition of methyl cyano-acetate to certain pentadienones. II. On substitution in benzene derivatives." Corliss Robert Kinney, "I. Studies in the isoxazoline oxide series. II. The mechanism of certain Grignard reactions." Robert Eliot Lutz, "A study of 1,4-unsaturated diketones." Howard Warner Starkweather, "I. The density of oxygen. II. A revision of the atomic weight of tin. III. The efficiency of calcium chloride, sodium hydroxide, and potassium hydroxide as drying agents."

Illinois

1922–1923: Virginia Bartow, "Attempt to prepare an aliphatic beta-diazo compound." William Wert Bauer, "Arsenated diphenyl and derivatives." Waldo Briggs Burnett, "Relation between physical properties and physiological action of certain local anesthetics." Adam Arthur Christman, "Biochemical studies on allantoin." Mayor Farthing Fogler, "Heat of vaporization of metals." John Hall Gardner, "Synthesis of trihydroxy-methyl-anthraquinones." Walther Friedrick Goebel, "Derivatives of camphoronic acid." George DeWitt Graves, "Synthesis of trihydroxy-methyl-anthraquinones." Wendell Horace Griffith, "Synthesis of hippuric acid in the organism of the rabbit." Russell Lewis Jenkins, "Relation between physical properties and physiological action of certain local anesthetics." Ralph Jennings Kaufmann, "Comparison of the reactivity of the cyano group in alkyl thiocyanates." Earl Emanuel Libman, "Determination of the surface tension of viscous liquids at high temperatures and note on ZnO as a refractory." Harry Louis Lochte, "Symmetrical di-isopropyl-hydrazine and related compounds." Louis Navias, "Calorimeter for determining the heats of reaction at high temperatures." Katherine Ogden, "Cinchophen derivatives containing arsenic derivatives of the diphenyl series." Charles Herman Peet, "Relation between physical properties and physiological action of certain local anesthetics." Philip Kelsey Porter, "Derivatives of isocampholactone." Thomas Adam Wilson, "Total and partial vapor pressure of aqueous ammonia solutions." Harry Fagan Yancey, "Sulfur forms in coal: their distribution and control."

1923–1924: John Wendell Andrews, "The entropy of carbon dioxide; a check on the third law of thermodynamics." Herbert Orien Calbery, "Cinchophen derivatives containing arsenic. Some new types of organic bismuth compounds." Wallace Hume Carothers, "The catalytic reduction of aldehydes with a platinum oxide

catalyst together with a study of the effects of numerous substances on the platinum catalysis of the hydrogenation of benzaldehyde." Ralph Conner Corley, "The fate of certain derivatives of glutaric and adipic acids in the animal organism." Emil Edward Dreger, "The relation between chemical constitution and physiological action of certain local anesthetics." Frank Howard Driggs, "Observations on the rare earths: the purification and atomic weight of holmium." Gail Phillips Edwards, "Investigations of the chemical reactions involved in water purification: some properties of precipitated alumina." William Uren Gallaher, "Investigations of the chemical reactions involved in water purification: Studies on the precipitation of calcium, magnesium and aluminum." Hermann Conrad Nies Heckel, "I. The catalytic reduction of aminophenols. II. Preparation of a series of local anesthetics of a new type." Wilford Kaufmann, "The catalytic reduction of furfural and derivatives." Irvin Alvin Koten, "A study of alkyl mercury hydroxides. II. Arsenic derivatives of phenyldiketopyrrolidine." Flora Marion Lougee, "Selenium compounds as spray materials." Samuel Marion McElvain, "Synthesis of a new bicylic nitrogen ring. Isogranatanine derivatives. Preparation of an isomer of homococaine." Joe Eugene Moose, "A re-determination of the heats of oxidation of certain metals." Lottie Ella Munn, "Studies in tellurium: the value of some tellurium compounds as disinfectants." John Stanton Pierce, "I. Tetrahydro-1,3,2-oxazones and substituted gamma-amino propanols. II. Catalytic reduction of furyl alkyl carbinols." Clifford Fred Rassweiler, "Some new 4-hydroxypiperidines. An attempted synthesis of a homologue of arecoline." Nao Uyei, "On the optically active dyes." Lyman Joy Wood, "Correlation of physical and chemical properties in alloys of the ternary type."

1924–1925: Wallace Reed Brode, "A study of optically active dyes, mechanism of dyeing and absorption spectra." Courtland Livingston Butler, "A study of the possibility of a new type of isomerism in the diphenylmethane series." Gerald Judy Cox, "The metabolism of histidine and related compounds." Archibald Edmund Gray, "Hexa-alkylethanes." Frank Hovorka, "The freezing points of very dilute solutions of electrolytes." Elizabeth Charlotte Hyde, "Studies in creatine metabolism." Richard Willet Jackson, "Studies in the metabolism of gelatin." Ralph Albert Jacobson, "The synthesis of trihydroxy-methylanthraquinones." John Williams Kern, "The catalytic reduction of olefines." Sheo Hen Li, "The oxidation of pyrites as a factor in the spontaneous combustion of coal." Edward Oscar North, "The preparation, properties and uses of silicoduodecitungstic acid." Charles William Rodewald, "I. Diketo-pyrrolidine derivatives containing arsenic. II. Arsono-arylamino alcohols." Roy Allen Shive, "The role of bio-precipitation in sewage treatment." Ralph Lloyd Shriner, "Palladium and platinum oxides as catalysts in the reduction of organic compounds." Florence Dell Stouder, "A study of the structure of rubiadin." Alfred Paul Thompson, "The preparation and properties of metallic yttrium." Frederick Ewart Vandaveer, "The use of oxygen in the manufacture of water gas." John Wierda, "The purification of praseodymium: the preparation and some of the properties of metallic praseodymium."

Indiana

1922–1923: Frederick Albert Madenwald, "Catalytic activity of lead." J. C. Warner, "Electrolytic preparations of the amidophenols."

1923–1924: Herman Thompson Briscoe, "The properties of dolomitic limes as related to the properties of the stones, the conditions of burning, and subsequent treatments."

1924–1925: George Clyde Hale, "The nitration of hexamethylenetetramine." Thomas Lee Smith, "I. The reduction of nitro compounds with iron and soluble chloride. II. Side chain oxidations by means of nitro compounds."

Iowa

1922–1923: John Russum Couture, "Role of weight in the migration of acyl from nitrogen to oxygen." William John Husa, "Studies on enzyme action: the relationship between the chemical structure of certain compounds and their effect upon the activity of urease." Arthur Roy Fortsch. "Free energy of dilution and activities of the ions in aqueous solutions of hydrogen iodide." Harry Matloch Hines, "Creatine metabolism."

1923–1924: Ralph Warren Gelbach, "The free energy of dilution and the activity of the ions in aqueous solutions of barium chloride." Herman Peter Lankelma, "The effect of acyl upon the migration from nitrogen to oxygen in *o*-aminophenols." Norris Onslow Taylor, "A preliminary study of the alloys of aluminum, zinc, and tin."

1924–1925: Alfonso Miguel Alvarado, "Absorption of vapors by metallic oxides; its bearing on the theory of heterogeneous catalysis of ester formation." Howard Thomas Beach, "The systems formed by certain inorganic compounds with liquid sulfur dioxide." Earl Perry Clark, "The behavior of mixed O-acyl-N-acyl derivatives where the reacting groups are not attached to adjacent carbon atoms." William George Eversole, "The determination of the degree of solvation of the ions of lithium chloride in certain alcohols by the transference method." Clarence Milton Knudson, "The absorption of certain vapors by charcoal at various temperatures up to and above their critical temperatures." James Laurence Whitman, "The standardization of solutions of sodium thiosulfate and iodine."

Iowa State

1923–1924: Walter Beno Bollen, "The influence of gypsum on biochemical conditions." Rayadurg Nagan Gowda, "Studies on nitrification and the nitrifying organisms." Glenn Garnet Naudain, "A study of the properties of wheat starch with reference to flour." George Norman Quam, "A study of reactions in liquid hydrogen sulfide."

1924–1925: Louis Theodore Anderegg, "Value of certain diets for growth and reproduction." William Vernal Halverson, "The nitrogen metabolism of nitrogen-fixing bacteria." Victor G. Heller, "The vitamine and nutritive value of yeast." Harold Lee Maxwell, "The influence of carbon monoxide and carbon dioxide on the equilibrium between carbon and cementite." Henry Max McLaughlin, "The effect of pressure on the decomposition of potassium chlorate in the presence of manganese dioxide.", Russell Marion Pickens, "I. The correlation of some aromatic types with physiological action. Local anesthetics containing the furan, thiophene and pyrrole nuclei. II. Studies in reduction. (*a*) The existence of hydrogenmagnesium. (*b*) The reduction of azo compounds." Frank F. Sherwood, "Yeast growth as affected by changes in physicochemical environment, with special reference to temperature effects."

Johns Hopkins

1922–1923: Thomas Morris Berry, "Alkylation of benzene, toluene, and naphthalene, and the chlorination of acetylene." Norman Fitzhugh Eberman, "Study of the adsorption from solution from the standpoint of capillarity." Duncan Graham Foster, "Addition of esters to phenyl nitro ethylene. Addition of nitromethane to

diunsaturated ketones. Influence of sulfur on the color of azo dyes." Thomas Brooks Grave, "Attempts to prepare 1-methyl 2-methoxy-piperidine: the hydrogenation of certain pyridine derivatives." Arthur Grollman, "Measurement of osmotic pressure and its application to a study of aqueous phenol solutions." Frederick Charles Hahn, "Some new substituted benzoyl-ortho-benzoic acids and their corresponding anthraquinones." William Curry Martin, "Effect of cod-liver oil and of butter fat upon the metabolism of calcium and phosphorus." Sidney Stevens Negus, "Vapor pressure of aqueous solutions of sodium chloride at twenty-five degrees centigrade." Walter Creigh Preston, "Study of adsorption phenomena in the vicinity of the critical temperature." Joseph Charles Swenarton, "Higher alcohols of fermentation." Roger Kirkbride Taylor, "Vapor pressure of aqueous solutions of potassium nitrate at twenty degrees centigrade." Willard Alexander Whitesell, "Activation of catalysts; a study of manganese dioxide and other oxides in the catalytic oxidation of carbon monoxide."

1923–1924: Charles Everett Bills, "Studies on the antiricketic vitamin." James Roy Eckman, "The determination of gases in metals by vacuum fusion." Clarence Eugene Garland, "Some new derivatives of cyclohexanone." Clarence Edwin Greider, "The heat of absorption at 0° of sulfur dioxide and water vapor by silica gel: The heat of oxidation at 0° of carbon monoxide and hydrogen by manganese dioxide." Rudolph Leonard Hasche, "The rate of reaction of nitric oxide and oxygen." Harold Stephens Holt, "The effect of sulfur on the color of triphenyl methane dyes and certain phthaleins." Archibald Stuart Hunter, "On the colloidal and physical chemistry of arsphenamine. The determination of the isoelectric point." Max Latshaw, "The rate of oxidation of nitric acid." Arthur Edward Owens, "Adsorption of nitrous oxide by silica gel." George David Palmer, Jr., "The influence of sulfur on the color of azo dyes." Osborne Robinson Quayle, "Some new benzoic acids and their corresponding anthraquinones." Dana Porter Weld, "Some studies on the system: manganese dioxide–oxygen."

1924–1925: Lee Wesley Blitch, "Manganese dioxide as an oxidation catalyst." Edwin Louis Cline, "Derivatives of ethylbenzene." Christian Vandegrift Holland, "The vapor pressure of aqueous solutions of hydrochloric acid at 25°C." Francis Christian Huber, "The relation of rate of stirring to rate of reaction." William Leonard Hyden, "The colloidal properties of soap solutions." Chang Sei Kim, "Some chemical and biological studies of the mung bean, Phaseolus Aureus Roxburgh." Walter Eastby Lawson, "Reactions of β,β'-dichlorethyl sulfide with compounds containing amino groups." Grace Lubin, "A study of the effect of surface tension and of surface curvature on the rate of evaporation of water." Carleton Hecker Schlesman, "Osmotic pressure of aqueous solutions at elevated temperatures." Edwin Herbert Shaw, Jr., "Some derivatives of ethyl selenomercaptan and a new method for the quantitative estimation of selenium in organic compounds."

Kansas

1923–1924: Edgar Lemuel Tague, "Researches on the chemistry of proteins."

1924–1925: John William Barker, "The absolute value of an electrode potential." Grace Moore Fleming, "Syntheses of thiazane derivatives." Robert Taft, "Oxidation and reduction."

Mass. Agric. Col.

1922–1923: Paul Serex, Jr., "Availability of nitrogen in some organic vegetable substances."

Mass. Inst. Tech.

1922–1923: Edmund Olin Cummings, "Study of the application of electrolytic reduction and oxidation to the production of certain organic compounds." William Ronald Frazer, "Investigation of the physical properties of a chrome-molybdenum steel and a nickel-chrome-molybdenum steel." John Howard Perry, "Equilibrium of the ammonia synthesis. Equilibrium between palladium and hydrogen." Edgar Reynolds Smith, "Contact potentials between monovalent bromide solutions. Transference numbers by the moving boundary method." Leighton Bruerton Smith, "Equation of state and some related quantities for pure nitrogen (gas phase)." Robert Seth Taylor, "Thermodynamic properties of methane. Vapor pressures, densities and some derived quantities for ether at low temperatures."

1923–1924: Avery Allen Ashdown, "The relative reactivity of the hydroxyl-hydrogen in certain alcohols." John Twiss Blake, "A study of the reactivity of chlorine in certain organic compounds." Harry Gray Burks, Jr., "The equation of state of gaseous mixtures." Edward Cadmus Haines, "The influence of the solvent on the rate of reaction between benzoyl chloride and ethyl alcohol." Charles Holmes Herty, Jr., "The interaction between gas, slag and metal in the basic open-hearth process." Reginald Stuart Hunt, "A study of the metabolic changes induced by high frequency electricity." John Lewis Keats, "The elimination of the metalloids in the basic open-hearth process." Raymond Henry Lambert, "Heats of neutralization with a continuous flow calorimeter: The heat of neutralization at constant concentration." Frances Jean MacInnes, "Quantitative studies on the efficiency of fungicides." Avery Adrian Morton, "A study of the rate of reaction between diphenylchloromethane and ethyl alcohol." Cyril Jerome Staud, "The rates of reaction of ethyl alcohol with benzoyl chloride and certain of its substitution products."

1924–1925: Robert Hollenbeck Aborn, "A comparative study of stress-strain relations in commercial strip steel and in the alpha iron crystals occurring therein." Armand Joseph Abrams, "Certain transformations of nitroguanidine." Robert John Anderson, "An investigation of the constitution, heat treatment and microstructure of duralumin." Jane Dewey Clark, "I. The alkalinity of dilute solutions of sodium palmitate. II. Transference numbers in mixtures of sodium and potassium chlorides." Per Keyser Frolich, "Colloidal phenomena in electrodeposition of metals." William Lester Gilliland, "The reaction of nickel carbonyl with Grignard reagents." Flemmon Porter Hall, "The system of palladium and hydrogen." Louis Harris, "The intensities of X-ray reflections." Henry David Hirsch, "The reactivity of the hydroxyl group in certain alcohols." Helen Thayer Jones, "A study of the reaction rates of certain esterifications." Eli Lurie, "I. Equilibrium in the systems: (*a*) $AgCl.3NH_3$–$AgCl.1^1/_2NH_3$–NH_3: (*b*) $BaCl_2$–$BaCl_2.8NH_3$–NH_3. II. Equilibrium pressures of ammonia in mixtures of ammonia and nitrogen." Horace Tharp Mann, "The effect of zinc oxide on the formation temperature of some ferrous slags." Spencer Ward Prentiss, "A contribution to the study of the influence of the solvent on reaction velocity." Ernest Wayne Rembert, "Some dynamical properties of flames." Raymond Reuter, "Rearrangements and cracking of the pentenes." Theodore Shedlovsky, "The intensity of reflection of X-rays from calcium fluoride crystals." Ernest William Thiele, "The mechanism of the steam carbon reactions."

Michigan

1922–1923: Glenn Clifford Forrester, "Study of three isomeric di-methoxy-triphenylmethyls, and the synthesis of some mono- and di-methoxy-tetra-aryl-methanes." Elroy John Miller, "Adsorption by activated sugar charcoal."

1923–1924: Leigh Charles Anderson, "A study of 3^1-3^2-3^3-Trimethyl-aurine (Ortho-cresaurine)." George Granger Brown, "The rate of pressure rise in gaseous explosions." Arthur Raymond Carr, "A study of the vapor pressure of organic solutions and the application of Dühring's rule in the calculation of equilibrium diagrams." John Collin Geniesse, "An investigation of the fundamental factors involved in fractional distillation." William James McGill, "A study in tautomerism; the ortho-hydroxy triarylmethyl carbinols." Daniel Arthur McGinty, "The problem of amino-acid synthesis in the animal organism; a study of some possible precursors of Lysine." John Franklin Ross, "The chromium-iron equilibrium in carbides in steel at 950°C." Avery Byron Soule, "α-Furildioxime as a reagent for the detection and determination of nickel. The determination of nickel in steel by means of α-furildioxime." Donalee Levi Tabern, "A study of the relation between color and constitution among the acridyls and other basic analogs of the triarylmethyls." Helen Updegraff, "The organic constituents of saliva." Gerrit Van Zyl, "The reaction between gelatin and electrolytes as shown by decomposition potential measurements."

1924–1925: Albert Becker Peck, "Changes in the constitution and microstructure of andalusite, cyanite, and sillimanite at high temperature and their significance in industrial practice." John Carl Pernert, "The methylbiphenyls."

Minnesota

1922–1923: George Oswald Burr, "Condensation of indole derivatives with aldehydes with especial reference to the humins of protein hydrolysis." Hyman Shalit Lippman, "Blood in the newborn period." Arthur Adelbert Zierold, "Reaction of bone to various metals."

1923–1924: Ernest August Fieger, "Hydrogen-ion concentration studies of Minnesota soils." Reynold Clayton Fuson, "Naphthalene and the centroid structure." Walter Fred Hoffman, "Studies on the prolamines." Hans Herman Jersen, "An experimental study of certain benzyl compounds with especial attention to the importance of substitution in the benzyl nucleus and the significance of the side chains." Arnold Harvey Johnson, "A physico-chemical study of cracker dough fermentation." Frank Carl Kracek, "The separation of radium and barium as chromates." Walter McClellan Lauer, "I. The action of bromine on the sodium salt of tribromophenol. II. The constitution of tribromophenolbromide and its congeners." Arthur Levine, "The oxidation of the halogenated 1,3-dimethyl ethers of pyrogallol." Arthur Edward Stoppel, "Studies in the analytical chemistry of molybdenum and vanadium."

1924–1925: Andrew Dingwell, "Studies of the proteins of wheat flours and their relation to flour strength." Arthur Hubert Kohlhase, "Studies in aromatic sulfur compounds." Minerva Morse, "The oxidation of trichlorophenol." Arnold Erwin Osterberg, "Chemical nature and physiological significance of thyroxin and related compounds." Landon Arndale Sarver, "The solubility relations of the rare earth oxalates." Reginald Carter Sherwood, "The control of diastatic activity in wheat flour." Maurice Visscher, "The transportation and storage of carbohydrate in the animal body." Ludwig Joseph Weber, "The detection of osmium, ruthenium, rhodium, and iridium."

Missouri

1923–1924: John Lewis Nierman, "The distribution of the mineral elements in the animal body as influenced by age and condition."

1924–1925: Nollie B. Guerrant, "The adequacy of synthetic rations for growth of chicks."

Nebraska

1922–1923: Bernard Clifford Hendricks, "Diffusion of hydrogen through hot metals."

1923–1924: Marschelle Harnly Power, "The oxidation of *d*-glucose by air in calcium hydroxide solution." Lila Sands, "The preparation and properties of *l*-mannonic and *l*-gluconic lactones." LeRoy Granville Story, "I. Studies of arsenic trioxide and arsenites. II. The effect of temperature on the equilibrium between benzaldehyde and benzoin."

1924–1925: Sul Bryan Arenson, "Oxidation and reduction of aldehydes from the standpoint of electromotive force measurements." Meyer Beber, "A study of the reaction between alkyl dihalides and sodium alcoholates." Carrell Henry Whitnah, "Studies on the structure of the lactones of the sugar acids."

New York

1922–1923: Martin Kilpatrick, Jr., "Measurement of velocity of reaction." Rudolph Macy, "Ternary system: silver perchlorate–aniline–water." Frederick William Miller, Jr., "Ternary system: silver perchlorate–toluene–water." Stephen Gottheil Rich, "Standardized tests in chemistry with relevance to social aims of instructional results." Edgar R. Wagner, "Chemical study of some arsonium and stibonium compounds." John Christie Ware, "Derivatives of choline."

1923–1924: Charles Frederick Fryling, "Reaction velocities and their temperature coefficients."

1924–1925: Milton Bergstein, "The catalytic effect of buffer solutions." William Marias Malisoff, "The mutual solubility of liquids." Clarence Daniel Luther Ropp, "Some molecular compounds and solubility of lithium perchlorate."

Northwestern

1923–1924: Gerald John Leuck, "A study of the mercuration of some polynuclear organic compounds." Herman Edward Redenbaugh, "An investigation of the heat production in pigeons on a diet deficient in vitamine B." Harold Winfred Stiegler, "The beta-chlorovinyl arsines and their derivatives." Neal Thurman, "The action of bases with organic halides."

1924–1925: Ernest Roy Hanson, "I. Preparation of ortho-iodophenol. II. Reactivity of the carbon-mercury linkage in mercurated phenols. III. Reactivity of the carbon-mercury linkage in mercurated anilines."

North Carolina

1922–1923: Samuel Clement Smith, "Constitution of the N,N′-β,β,β-dichlorohydroxyethylidene-bis-nitroanilines."

Notre Dame

1923–1924: Sister Mary Lucrétia, "The preparation of oxalic acid from acetylene."

Ohio State

1922–1923: Calvin Adam Buehler, "Oxidation of glucose, galactose, lactose by means of alkaline potassium permanganate. Merle Leroy Dundon, "Refined measurements of the conductivity of slightly soluble electrolytes." Joseph Frederic Haskins, "Contributions to the chemistry of titanium." Elmer Herman Haux, "Catalytic cracking of petroleums." Carl Waldo Holl, "Oxidation of certain hexitols." Edward Charles Hytree, "Oxidation of propylene glycol in alkaline solution." Clare S. Martin, "Electrolytic preparation of highly concentrated alkali and

alkaline earth amalgams." Gerard Gordon Osterhof, "Relation between the physical characteristics of lime and its time-temperature burning curves." Gordon Derby Patterson, "Sulfur dioxide-iodine methods." Ying Lam Pun, "Comparative study of the determination of ash in sugar." James Thomas Robson, "Dead burning of dolomite." Lorin Beryl Sebrell, "Preparation and properties of 1-mercapto benzothiazole and its derivatives." Lawrence Edward Stout, "Study of electroendosmose."

1923–1924: William Hale Charch, "An extension of the study of the chemical control of gaseous detonation." Edwin Nelson Cole Coolidge, "A study of the relation between the constitution and accelerator value of certain organic compounds." Marion Donald Coulter, "The absorption spectra of dimethyl-aminoazobenzene and related derivatives." Richard Andrew Crawford, "The oxidation of maltose and cellose with potassium permanganate." Homer Leslie Cupples, "A study of the factors governing rate of solution." Howard Earl Fritz, "The rate of absorption of hydrochloric acid gas in the Tyler vitreosil system." Roy Israel Grady, "A new and precise method for measuring the density of liquids." Robert James Havighurst, "X-ray analysis of crystals." Arthur Van Henry, "The electrical conductivity of refractories at high temperatures." Cloyd Delson Looker, "The oxidation of sucrose and its component monosaccharides with potassium permanganate." John Dorman McBurney, "A study of the influence of hydrophillic colloids on the grain size and distribution of basic lead carbonate electrolytically precipitated." Edward George Meiter, "Vapor pressure vs. flash point of petroleum products." Walter Harrison Moran, "The influence of gelatin on the transference numbers of hydrochloric acid by the concentration cell method." Joel Bigelow Peterson, "A study of the absorption spectra of ortho-phenylazophenol and its derivatives."

1924–1925: Andrew Irving Andrews, "Dolomite investigation." Arthur Talbot Bawden, "Further studies of the comparative values of different specimens of iodine for use in chemical measurements." Jacob Work Bulger, "Studies of the uses and limitations of elemental sulfur as a soil insecticide." Aubrey Ottarson Bradley, "The absorption spectra of phenylazo-alpha-naphthol and some of its substitution derivatives." Leonard Thomas Capell, "Synthesis and constitution of ortho quinones." Howard Leroy Dunlap, "The neutral salt effect of alkali and alkaline earth chlorides upon hydrochloric acid in the ketonic splitting of ethyl acetoacetate." Rachel Hartman Edgar, "The alkaline oxidation of glucose." Robert Stewart Hanson, "A study of the catalytic action of anhydrous metallic halides in organic synthesis." Henry Bohn Hass, "The action of potassium hydroxide upon *d*-1-glyceric aldehyde." George Preston Hoff, "The effect of potassium hydroxide on *d*-galactose." William Samuel Jones, "A study of the resistance of metallic chemical engineering materials to corrosion by phosphoric acid." Clarence William Kreger, "The oxidation of raffinose and equivalent mixtures of its hydrolytic splitting products by means of neutral and alkaline potassium permanganate." Alfred Ernest McGee, "The heat required to fire ceramic bodies." John Mouk Ort, "Membrane potentials." Robert Ambrose Osborn, "A precision measurement study of sodium carbonate as a standard substance." Henry Francis Palmer, Jr., "The partial pressures of aqueous hydrochloric solutions." Louis Abell Pappanhagen, "Metallic silver as an ultimate standard in volumetric analysis." Marion Capps Reed, "A correlation of the ability of organic bases to form sulfides, polysulfides and thio-zinc salts with their power to accelerate rubber vulcanization." Harold Theodore Reiner Ruff, "Barium saccharate." Thomas Hadden Swan, "Vapor pressure of organic crystals." Donald Statler Villars, "Effect of light on electrode potentials." Helen Landman Wikoff, "A study of the relation of the

absorption spectra of certain organic compounds to their structural symmetry." Arthur J. Yaney, "A study of the absorption spectra of some aliphatic ethers."

Pennsylvania

1923–1924: Horace Richard Blank, "The allotropy of germanium dioxide." Maurice Henry Fleysher, "The activity coefficients and transference numbers of hydrochloric acid in alcoholic solutions." Edwin Frederic Pike, "Studies of the preparation of germanium and certain of its compounds." Russell Davis Sturgis, "The free energy of dilution of sulfuric acid in the presence of certain sulfate electrolytes."

1924–1925: Frank Evans Swindells, "Some thermodynamic properties of lithium hydroxide and the dissociation of water in lithium chloride solutions."

Pittsburgh

1922–1923: Thomas Briley Downey, "Derivatives of 2,4-dinitrobenzaldehyde." Arthur Mark Howald, "Catalytic ammonolysis of β-naphthol and chlorobenzene." Charles Luther Jones, "Retorting of oil shale." Charles Glen King, "Derivatives of para-nitrobenzaldehyde." Gilbert Edward Seil, "Chemical reactions as influenced by the subdivision of the reacting substances." Blaine Benjamin Wescott, "Catalytic decomposition of formic and acetic acids."

1923–1924: Raymond Frederick Dunbrook, "Electrolytic oxidation of toluene, *p*-nitrotoluene and *p*-chlorotoluene." Elmer Victor Hjort, "Selenium galvanometric colorimeter." Paul O. Saunders, "The composition of ozone and the free energy factor in ozone formation." Willard James Sutton, "Electrical conductivity of sodium chloride in molten glass." Kendall Seibert Tesh, "Electrolytic preparation of phenylhydrazine and salicylaldehyde."

1924–1925: Glenn D. Kammer, "Ionium and thorium in Colorado carnotite." William Wright Lewers, "A comparative study of azo dyes made with H-acid and acetyl-H-acid." Arthur Newton Parrett, "The catalytic reduction of nitronaphthalene to naphthylamine." Paul Odell Powers, "A study of the utilization of light wood oil." Jacob Ellia Rosenberg, "Adsorption of ions on metallic surfaces and its effect on electrode potentials." William Augustus Rudisill, "Catalytic activation of titania." Arthur Eugene Wood, "The action of petroleum refining agents on pure organic sulfur compounds dissolved in naphtha."

Princeton

1922–1923: William Theodore Anderson, Jr., "Inhibition of the photochemical decomposition of hydrogen peroxide solutions." John Howe Yoe, "Application of physico-chemical principles to the problem of canister design."

1923–1924: Ralph Alonzo Beebe, "A direct method for the measurement of heats of adsorption of gases on metals and some values for hydrogen on nickel and copper." John Sherman Beekley, "The adsorption of silver salts by silver iodide." Henry Coburn Howard, Jr., "A study of the density of charcoal." Robert Franklin Mehl, "Experiments on the preparation of very pure alloys and a preliminary study of the system aluminum magnesium." Donald Howard Powers, "A study of some new hydroxamic acids of hydroxy and alkoxy fatty acids." William Rogers, Jr., "The rate of oxidation of linseed oil." Thomas Jefferson Webb, "The third law of thermodynamics and the calculation of entropies." Herbert Franklin Whalen, "Tertiary amines and acid chlorides."

1924–1925: George Richard Burns, "Trihydroxytriethylamine oxide and substituted hydroxylamines with hydroxyethyl radicals." Walter Arthur Dew, "The adsorption of ammonia gas by metallic catalysts." Merrill Wilmer Seymour, "The

action of sodium triphenylmethyl upon trimethylmethoxylammonium iodide." Everett Stanley Wallis, "The Beckmann rearrangement involving optically active radicals."

Stanford

1922–1923: Imo Pearl Baughman, "Colorimetric method for the determination of tannin in small amounts and its application in a study of tannin-gelatin reactions." William Leroy Burdick, "Some ammono carbonic acids and their reactions in liquid ammonia." Leo Francis Pierce, "Study of a longitudinal field Poulsen arc converter."

1923–1924: James Stuart Blair, "Mixed aquo ammono carbonic acids." Ernest Herman Brunquist "Acid production in the basic metabolism of excised muscle (frog) as affected by certain slight changes in the liquid environment; and the question of response to adrenalin." Floyd DeEds, "I. Quantitative methods for the determination of formic acid in blood and urine. II. The fate of hexamethyleneamine in the body and its bearing on systematic antisepsis." Louis Dunshee Elliott, "The molecular lowering of the freezing point of liquid ammonia." Edith Hawley, "Food factors in the cost of living." Laurence Irving, "The carbonic acid-carbonate equilibrium of sea water and its relation to respiration and metabolism in starfish." Charles Edward Maw, "Studies on the oxidation of sodium sulfite and some catalytic influences affecting it." Olaf Selmer Rask, "A viscosimetric study of wheat starches."

1924–1925: Faw-Yap Chuck, "Nitridation: ammono nitric acid and ammono hypo halogen acids as nitridizing agents." David Bruce Dill, "Gluten studies."

Virginia

1922–1923: Gilbert Ivo Thurmond, "Lactic acid and its anhydrides."

1923–1924: Joseph Russell Branham, "Rate of flow of various gases through capillary tubes." Chi Chao Yung, "The catalytic dehydration of ethyl alcohol in the vapor phase."

1924–1925: Roy Selden Cook, "A quantitative study of the reversible reaction, nickel oxide plus hydrogen giving nickel plus water." Carl Alfred Harris, "A study of the kinetics and temperature coefficient of the catalytic hydrogenation of ethylene by copper." Carl Peter McNally, "The ionization constants of creatinine and creatine."

Washington Univ. St. Louis

1922–1923: Theodore Edward Friedemann, "Phenomenon of antiketogenesis."

Washington

1923–1924: Waldo Lonsbury Semon, "The precipitation of metals by hydrogen sulfide. A study of certain sulfur complexes of mercury."

1924–1925: Carl Zeno Graves, "Reaction of sulfur with alkali and alkaline earth hydroxides in aqueous solutions and a study of the coagulation of mastic suspensoids." Malville Fletcher Perkins, "A laboratory study of nitrogen fixation in the high tension arc."

Wisconsin

1922–1923: Roland Martin Bethke, "Inorganic relations in the body tissues of rats on various deficient diets." Swaminath Subrahmanya Aiyar, "Study of the distribution of methoxyl in the products of different treatment of wood." Howard Newton Calderwood, Jr., "Examination of the dissolved tar obtained from the

destructive distillation of hard maple (*Acer saccharum* Marsh)." Frederic LeRoy Conover, "Behavior of certain oxides and silicates with carbon tetrachloride." Carl Emmit Frick, "Action of selenium oxychloride on certain unsaturated hydrocarbons." John Donald Jenkins, "Study of the factors influencing the velocity of crystallization of substances from supersaturated solutions." Arlington Colton Krause, "Study of the compounds of molybdic and tungstic acids with some organic nitrogen bases. System of orthoboric acid and pyridine." John Metschl, "Supersaturation of gases in water and certain organic liquids." Clarence Weinert Nuehlberger, "Products of the reaction of selenium dioxide with the hydrohalogen acids. Toxicity of selenium dioxide." Ray V. Murphy, "Conductivity studies on colloids." Elmer Martin Nelson, "Properties of vitamin A." Llewellyn Bradley Parsons, "Study of the effect of small concentrations of water on certain chemical reactions." Ethel Ronzoni, "Acid-base equilibrium of the blood in exercise." Benjamin Johannes Smit, "Fishy flavor of butter." Robert Vernon Williamson, "Study of the factors influencing the rate of absorption and equilibrium of carbon dioxide in alkaline solutions."

1923–1924: Elmer Wade Adams, "A study of catalysis and of reactivity in the formation of acetals." Fritz Emil Bischoff, "Organic reactions at the surface of titania. Selective activation of the catalyst." Aubrey Keith Brewer, "A study of ionization produced during certain gas phase reactions." William Clark Child, "The catalytic condensation of aldehydes to esters." Louis Benjamin Haines, "The behavior of organic compounds with nitrogen pentoxide." Alrick Brynhjolf Hertzman, "Studies on proteolysis." James Hazlitt Jones, "A study of the factors operative in rickets in dogs." Arlie Paul Julien, "The electrical conductance of selenium oxychloride solutions." Walter Alexander Kenyon, "Digestive enzymes of poikilothermal vertebrates." Michael William Klein, "The action of selenium oxychloride on some condensed aromatic compounds." John Ralph Koch, "A study of dialysis with sterol membranes." Walter Allos Koehler, "The heat of wetting of lead sulfate." John Roberts Lewis, "The viscosity of liquids containing dissolved gases." Oscar Conrad Magistad, "The amount of aluminum in the soil solution and its relation to soil reaction and plant growth." Emil Gustave Schmidt, "Production of *l*-leucic acid (α-hydroxyisocaproic acid) by *B. granulobacter pectinovorum*." Norman Dunshee Scott, "Some studies in the cataphoresis of proteins with particular reference to the effect of hydrogen-ion concentration on their mobility." John Vernon Steinle, "A new method for the identification and estimation of cholesterol and certain other compounds." Martin Tosterud, "A study of the fluorides and double fluorides of aluminum." Vandeveer Voorhees, "Some new derivatives of barbituric acid." Earl Lester Whitford, "The decomposition of certain dicarboxylic acids." Albert Gayland Young, "The relation of the chemical constitution of certain organic arsenical compounds to their action on the optic tract."

1924–1925: Franklin James Bacon, "Pharmacognostical study of digitalis purpurea." Archie Black, "Antirachitic activation." Gustav Bohstedt, "A study of the mineral and vitamin requirements of growing pigs with special reference to the effect of diet on bone development." Elbert Dysart Botts, "Metallic uranium, its preparation and some of its properties." Bernard Paul Domogalla, "Forms of nitrogen in lake waters and their relation to certain types of bacteria." Carleton Henningsen, "The mechanism of oil preservatives." Carl Arthur Hoppert, "Factors influencing calcium assimilation." Olaf Andreas Hougen, "Ammonia transfer coefficients in absorption towers." Herman Heald Kahlenberg, "Boron and boron suboxide." Elmer Otto Kraemer, "Studies with the kino-ultramicroscope." Wilbur Arthur Lazier, "Organic reactions at the surfaces of dehydrogenating catalysts." Samuel Lepkovsky, "A study of the distribution and properties of

the antiscorbutic vitamin." Karl Paul Gerhardt Link, "A study of the effect of temperature upon the composition of corn seedlings, especially the nature and character of the principal carbohydrates in relation to resistance to seedling blight." Ralph Bryant Mason, "A study of the solubility, decomposition, potentials, polarization, and transition temperatures of certain metallic chlorides in anhydrous pyridine." Edgar DeBolt McCollum, "The heat capacity of the system nitrogen tetraoxide and nitrogen dioxide." Fredus Nelson Peters, "The preparation and study of some new furane derivatives." William Henry Pierre, "The H-ion concentration of soils as affected by carbonic acid and the soil water ratio, and the nature of soil acidity as revealed by these studies." H. A. Holden Pray, "A study of the stability of diazo-benzene chloride solutions." Alfred Crawford Robertson, "Promoter action in homogenous catalysis." Ben Wright Rowland, "A thermochemical investigation of the action between gelatin and certain acids, bases, and salts." Henry Lenzen Schmitz, "A study of two series of procaine derivatives, with reference to the relationship between their pharmacological action and chemical constitution." Matthew Hsiung-Ching Shen, "Hydrogenation of fatty acids and their esters." Hugh Longwill Templeton, "The action of arsenious chloride on phenyl-*p*-toluidine, and its derivatives." Eugene Jacob Wechter, "I. The preparation of selenic acid and the selenates. II. The action of ozone on certain selenium compounds." John Warren Williams, "The specific heats of certain organic liquids and of binary mixtures." Lloyd Leo Withrow, "Preferential absorption on alumina."

Yale

1922–1923: Donald Hatch Andrews, "Some calorimetric methods for organic substances." William Thomas Caldwell, "Researches on pyrimidines: orotic acid." Francis Huntington Case, "Action of diazomethane on cyclic ureides." Armand Rene Collett, "Solubility of the isomeric nitranilines." Harry James Deuel, Jr., "Chemistry and physiology of the pyrimidines, thymine and uracil, with reference to nucleic acid metabolism." Henry Charles Eckstein, "Study of fat absorption with special emphasis on the possibility of lecithin synthesis in the small intestine." Bruce Houston, "Utilization of nitrogen tetroxide as a reagent for diazotization." DeWitt Talmage Keach, "Ethers of diethyl malonate and barbituric acid." Walter Dwight Kline, "Equilibrium in the system magnesium carbonate–carbon dioxide–water." Girard Theodore Kohman, "Thermal relations in ternary systems of ortho-meta-para isomers." Precious Mabel Nelson, "Role of maternal diet during lactation in the nutrition of the young." Henry Oscar Nicholas, "Some new derivatives of phenylethylamine." Isadore Rabinowitz, "Local anaesthetics of the holocaine type." Edward Wells Rugeley, "Experimental study of some reactions of ethyl γ,γ-diethoxy-acetate and their utilization for the synthesis of glyoxalines." Francis Lloyd Simons, "Catalytic decomposition of glycerides." Floyd Thaddeus Tyson, "Study of dehalogenation as applied to dihalides." Albert Charles Walker, "Equilibrium in aqueous solutions of the alkali carbonates."

1923–1924: Robert DeWolf Coghill, "The hydroxy-phenyl hydantoins and their antiseptic properties." David Davidson, "Ureides of pyruvic acid." Alfred West Francis, "A study of the directive influence of substitutents in the benzene ring by means of bromination." Ralph Eugene Montonna, "Constitution and properties of esters, *a*-chloroesters and acyl halides." Francis James Norton, "Vapor pressure and solubility relations of salt hydrates." Bernard Emms Read, "Studies upon the pharmacology of oil of hydnocarpus (Chaulmoogra)." Alfred Schultz, "A synthesis of oxindole derivatives from isatin." Elbert Minor Shelton, "A chemical study of sericin."

1924–1925: Howard Horace Beard, "An experimental study of dietary factors and dietary deficiencies in relation to the nutrition of white mice." Earl Matthias Bilger, "Thermolysis of organic esters and related compounds." Leon Alson Bradley, "The decomposition of cellulose by aerobic bacteria." Ulric Bannister Bray, "Activities of ions at equilibrium in the system alkali–carbon dioxide–water." Charlotte Pauline Burt, "Studies on cellulose chemistry: properties of some gamma delta dihydroxyketones." Theodore Keirstead Cleveland, "The preparation of 3-keto-tetrahydroquinoxaline and some of its derivatives." Mildred Virginia Cox, "Ester-substituted amidines of the holocaine type." Hilda Marion Croll, "The distribution of vitamin B in the maize kernel." Alice Dimick, "Studies on the pharmacology of arsenic." Marion Spencer Fay, "Nitrogen and sulfur metabolism in the dog." Lorenz Peter Hansen, "Some new synthetic applications of acenaphthene." George Lynn, "The heat-content of some benzene derivatives." Hymen Samuel Mayerson, "The effect of radiation and of darkness on metabolism in the dog." John Langdon Parsons, "The oxidation of cellulose." Florence Irene Peterman, "Studies in the pharmacology of aluminium." Evald Laurids Skau, "The freezing-point-solubility relations in systems of geometric isomers."

The absolute justice of the system of things is as clear to me as any scientific fact. The gravitation of sin to sorrow is as certain as that of the earth to the sun and more so, for experimented proof of the fact is in reach of us all—nay, is before us all in our own lives, if we had but the eyes to see it.—*Huxley*

The discovery of zinc in the Sudbury nickel district of northern Ontario is said to have led to the formation of plans by an American syndicate to test the size of the deposits by drilling. At the present time the Province of Ontario produces no zinc—British Columbia being Canada's chief source of supply.—*Compressed Air Magazine*

RADIO TALKS ON CHEMISTRY

"Chemistry and Human Progress"

A series of talks to be broadcast Wednesday evenings at 8.15 P.M., Eastern Standard Time, from the University of Pittsburgh Studio of Westinghouse Station KDKA.

Jan. 6. "Chemistry Advancing Civilization," Alexander Silverman.
Jan. 13. "Maintaining a Safe Milk Supply," Chas. Glenn King.
Jan. 20. "From Atmosphere to Soil," Kendall S. Tesh.
Jan. 27. "Dyes as a Civilizing Factor," Alexander Lowy.
Feb. 3. "Explosives and Human Progress," Gebhard Stegman.
Feb. 10. "Speeding up that Process," Carl J. Engelder.
Feb. 17. "Where Will Chemistry Lead Us?" Alexander Silverman.

Following the broadcasting of this series, these talks will be printed in *Radio Publication* No. **21,** which may be secured at the conclusion of the series by writing to the Radio Manager, University of Pittsburgh, Pittsburgh, Pa.

Correspondence

SIR EDWARD THORPE, C.B., F.R.S.

Dr. Hart sends this little note of a day spent in the company of the late Sir Edward Thorpe, in the hope that it may be of interest to some of our readers.

In 1896 I went to England to sell my nitric acid condenser then just patented. I learned before leaving home that Dr. Morely had visited England and had not had a very pleasant visit, chiefly because he had taken no letters of introduction; so I provided several. Among these was one to Professor Thorpe then chief chemist to the British Government, with his office and laboratory at Somerset House on the Thames Embankment. He was very kind and asked me to spend the next Sunday with them on the Thames. I met him at the time and place appointed and was introduced to Mrs. Thorpe, to his young lady secretary, whose name I have lost, and a nephew who was "very jolly, don't you know." We embarked on Professor Thorpe's steam launch which he managed himself. When noon came, the launch was tied to a tree on the bank and we ate the lunch which Mrs. Thorpe had prepared in the cabin. I have forgotten how far we had gone when it came time to return; but I know we had passed through several locks crowded with skiffs filled with young folks out for the day, among whom "Arry and Arriet" were much in evidence. It was a very jolly crowd and we enjoyed their chaff. All the necessary dishes, napkins, food, etc., had come in a hamper and this, after the launch had been safely housed, Professor Thorpe and I carried with us on the return trip on the Underground to his home on Notting Hill where we ate supper at 10 P.M. At that time Professor Thorpe was Secretary of the Chemical Society and I was Editor of the *Journal of the American Chemical Society*. As he was older and more experienced I learned much more from our conference on how to carry on such work than did he. He was trying then to get the full names and not merely the initials of the members of the Chemical Society.

Professor Thorpe was a man rather below the average height with a pleasant, rather shrewd face, and a pleasing personality. His letters to me subsequently, up to the time of his death, were all written in longhand, precise, well worded, and very full. Some of them were quite long—as many as eight pages of note paper. In this he followed the

fashion of Professor Henry E. Armstrong and the late Dr. R. W. Raymond who followed the same practice during his whole life. Only untiring industry could have made such a habit possible. He was industrious and has left a record of which his friends may well feel proud.

EDWARD HART

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EASTON, PA.

"THE LAW OF AVOGADRO"

To the Editor:

Let me call your attention to an error, or at least an ambiguity, in the article on "The Law of Avogadro" which appeared in the November number of the JOURNAL.

The author of this article has attempted a so-called "deductive proof" of Avogadro's Hypothesis. It is thoroughly familiar to all how this principle arises out of Gay-Lussac's Law of Combining Volumes and (as the author correctly points out) from the Law of Combining Weights. In the traditional development of this topic we are led to see that as a result of these two principles the number of molecules in equal volumes of different gases must be *either* equal or simple multiples of each other. Avogadro's Hypothesis, of course, merely fixes the choice on the first and simplest alternative.

In the author's "deductive proof" the equation, $V_1/V_2 = n_2/n_1 \times N_1/N_2$ is used, where V_1/V_2, the ratio of combining volumes, and N_1/N_2, the ratio of total molecules reacting, are both whole numbers, *whence*, the author suggests, n_2 cannot be *not* equal to n_1 (the numbers of molecules in equal volumes). The mathematical fallacy of this is apparent, however, for to fulfil the conditions it is only required that $n_2 = bn_1$, where b is *any* whole number, not necessarily 1. And this gets us nowhere with respect to fundamental assumption of Avogadro's Hypothesis.

NORRIS W. RAKESTRAW

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OBERLIN, OHIO

CAN YOU HELP US?

We publish the following letter from Dr. Silverman in the hope that some of our readers may be able to supply the desired information.

At the Los Angeles session of the Division of Chemical Education someone quoted Le Chatelier as having said, "Students are not re-

ceptacles to be filled, but fires to be enkindled." I do not recall who made this statement, but I am very anxious to get the original reference. If you can obtain same for me, I will greatly appreciate the coöperation.

A. SILVERMAN

UNIVERSITY OF PITTSBURGH,
PITTSBURGH, PA.

Opticians Told of New "Artificial Sunlight." A method of changing the light from a nitrogen-filled incandescent lamp to the same color as that from the noonday sun, without the use of dyed filters, colored glass or solutions, or any of the usual devices, was described to the members of the Optical Society of America by Dr. Irwin G. Priest, of the U. S. Bureau of Standards at Washington.

Dr. Priest's apparatus was designed in order to permit "artificial sunlight," important in many industries which require accurate color matching, to be standardized. It depends on the use of polarized light, which is light made to vibrate in one direction, instead of promiscuously, like ordinary light, by what the physicist calls a Nicol prism. If a beam of polarized light is allowed to fall on another such prism parallel to the first, it will pass through. If the two are at right angles, however, the beam will not pass through unless some material is placed between them which has the power of rotating the plane of vibration. Quartz or "rock crystal" has this power, but does not rotate all colors to the same extent. By arranging the quartz plate and the prisms properly, the apparatus will appear blue if one looks through it. If light from an incandescent lamp is passed through, it will be converted into a light closely resembling daylight. As no actual colors are present in the system used to filter the light, there is nothing to fade, and it can be accurately standardized, said Dr. Priest.—*Science Service*

Sewage to Yield Valuable Gas Fuel. Cities of the future will have their gas works located near their plants for the disposal of sewage wastes, and scientific thrifts will recover for fuel a useful gas now wasted into the air. Light and heat from the gas obtained as a by-product in the treatment of sewage is a practicable possibility, according to the report made by the Illinois State Water Survey to the Board of Natural Resources and Conservation of that state. Experiments conducted by the Survey indicate that in a city of fifty thousand inhabitants the quantity of combustible gas given off each day by the sewage in the treatment tanks is more than ninety thousand cubic feet.

This gas contains 70 per cent methane, the chief combustible constituent of natural gas, and has a heating value equivalent to 700 British thermal units per cubic foot, while the value of the common fuel gas is 550 to 600 units. The other constituents of the gas, carbon dioxide and nitrogen, are inert, and the gas itself has no more odor than ordinary fuel gas.

The gas is produced in the digestion process which the sewage liquor undergoes in the Imhoff treatment tanks, and formerly escaped into the air. It has been known for a number of years that this product will burn readily, but city officials and sewage plant operators have not heretofore realized the gross value of the gas that goes to waste each day.

The Illinois State Water Survey, with funds assigned by the Chemical Foundation, is experimenting with the collection and utilization of this gas and is developing a new type of treatment tank which is designed to give the maximum yields of gas.—*Science Service*

CLASS-ROOM CHEMICAL EMANATIONS

Air should be regarded as a mixture rather than as a definite compound because it passes through a porous plaster like a mixture.

The Carbon in our bodies comes from the food we eat, chiefly carbonates.

Nitrous oxide is called laughing gas because it is used by dentists.

Organic chemistry is a big chapter in inorganic chemistry.

Red phosphorus is used for matches so that people who are in the habit of chewing matches will not suffer.

Match sticks are made by means of a machine with small holes in it and a big log pushed through them.

Water glass is the glass which is used for making tumblers.

Galvanized iron is iron which is used for making galvanometers.

The absorption of water from the air by Calcium Chloride is called desecration.

Gunpowder is mixed thoroughly so as to fool the ingredients into thinking they are a compound.

When a porcelain dish is held in the luminous bunsen flame one obtains a deposit of burnt carbon.

Sulfuric acid contains 208% hydrogen.

Normality factor is that factor which when added in the correct amount, produces, or tends to produce, equilibrium in a solution.

An example of "reduction" is when water is boiled down it is reduced to a smaller amount after a bit.

Hydrogen is produced by putting acid on Pennangonize dioxide.

A molar solution of potassium nitrate is a solution of KNO_3 and H_2O being combined atomically.

A solution is a combination of homegenial bodies which are suspended relatively far apart.

Lamp black is the black substance formed called "suet" when a piece of glass has been smoked.

Solution is a heterogenous mass having a characteristic body and has no varied limits in its mixtures of the compounds.

Minus 273 degrees was just a convenient number for the man who set up the scale of degrees. That is the degree on which a temperature is most easily set.

Nitrous oxide is called Laughing Gas because it makes a noise when mixed with water.

Temporary and permanent hardness of water signifies whether the water is in the form of snow or ice.

Red Phosphorus is used in place of Yellow because the Yellow wears out the workers' jaws.

Plaster of Paris is taking $MgSO_4$ without water but with a little Silica.

Chemical Digest

HIGH-SCHOOL CHEMISTRY AND THE EVERYDAY LIFE OF THE PUPIL*

Chemistry is the servant of many other sciences; minerology, dietetics, agriculture, entomology, medicine, sanitation, as well as production manufacturing. It is intimately related to industry, to commerce, to the community, and the home. When the student senses these ties of the subject he begins to see it as capable of making transformations and working scientific wonders as marvelous as ever the Alchemists dreamed of.

Emphasis of the general principles need not be abandoned for these life connections. Life situations dealing with such interests as photography, the automobile, or fire works may initiate the student into the subject but in the end he finds the essentials, the "gist of the matter," in a limited number of general principles.

Over against the academic interest, which will be the motive for most high-school students, there will be, for some, the vocational interest. The desire to be an analyst, or a chemical engineer, or a teacher of science, or a research worker will prompt these students to a study of the subject.

High-school pupils are forward-looking altruists. Problems demanding solutions not yet found are, to them, attractive. The motor fuel problem, synthetic medicines, utilization of waste, and by-products, all are bids for their desire to help remake the world. The teacher who helps them to get a feeling of responsibility for this part of the "world's unconquered" future will have no lack of interest. Many of the chemists who shall solve these needs are now in our high schools. It is a part of the high-school teacher's privilege to help them to that life service.

H. R. SMITH

PUBLICITY FOR CHEMISTRY

Several recent articles have called our attention to the need for more publicity in the field of chemistry. Chemistry, in spite of its usefulness to the public, still remains a "remote" science and mention of chemical terms is lacking almost entirely in our greatest of advertising mediums, the newspaper.

* An abstract of a paper read before the Physical Science Section of the Nebraska State Teachers' Assoc. by R. S. Mickle, Nov. 6, 1925, Lincoln, Nebr.

An editorial in *Canadian Chemistry and Metallurgy*[1] asks, "Why not more chemistry in elementary education?" Logically, this would seem a profitable starting point for the furtherance of the knowledge of chemistry. Quoting from this article, "If a child can be satisfied with the idea that there are only so many letters in all the words of the language, what is difficult about the concept that there are only so many different elemental substances in all the natural objects of the world? What a soul-satisfying and simple conception." It is pointed out that, "As a class, teachers, inspectors, educational authorities, ministers of education, and all concerned with the system of primary and secondary education, are weak in science. As a class, science teachers in the secondary schools are weak in chemistry. Only a small per cent are very highly trained in chemistry as a science, and practically none have had any industrial experience on which they could fall back in order to put any life into the subject as taught." The conclusion is that, "Making chemistry commonplace is simply following the age-long practice, whereby ideas are passed down, so that the most brilliant, original thought of one generation becomes the elementary education of succeeding times."

The same situation is noted in a comment which comes to us from an English publication.[2] The attitude of the public toward chemistry is shown by the following quotation:

"The appearance in the daily press of regulations controlling the use of preservatives in food was an occasion of much interest in many ways, one of which was the reproduction in print of the formulae for sulfur dioxide and benzoic acid. Such an event is sufficiently rare—one wonders if it is unique—to attract some attention and it leads to the inquiry why the event should be either rare or unique. The language of chemistry is at times reproached for its obscurity to the plain man, but special pleading of this kind does not move us. A little acquaintance with other branches of science shows that the possibility of a scientific jargon is no impediment to popularity with the public which has taken to itself the many new and curious terms of broadcasting without any reluctance. Yet chemistry is a science that is singularly broad in its appeal. It affords abundant material for the exercise either of the imagination or the sense of logic. . . . . Yet, almost every day, we find some inoffensive chemical maligned and some discovery announced that would be good if it were new, or that is too good to be true. Perhaps, some day, the great newspapers will have chemistry editors just as they have sports and fashions editors. That time will not be long. We have noted with approval the excellent work some chemists are doing in writing on chemical topics in the daily papers. . . "

[1] *Can. Chem. & Met.*, **9**, 193 (1925).
[2] *Chem. & Ind.*, **44**, 432(1925).

Still further, a reviewer[3] of "Phases of Modern Science," a book compiled by the Royal Society of England, writes on publicity and science as follows:

"The literary public is hardly dealt with where science is concerned. In periodical literature, as often as not, and with a few notable exceptions, the choice lies between what is technically accurate and dull and what is sensational and quite untrustworthy. This generation has seen science take its place as an essential element in education, and scientific experiment, once carried on in fear and secrecy, has now become a part of every boy's work at school. Indeed, with such innovations as electric bells and lighting, telephones and wireless, it is practised in every household. Yet there seem few enough writers who, having the necessary knowledge of science and, more important, understanding and enthusiasm for the objects and purposes of research, combine with these qualities the purely literary faculty for selecting and arranging material and presenting it in readable form." W. R. W.

Dutch Chemist to Teach at Cornell. Prof. Ernest Cohen of the University of Utrecht and president of the International Union of Pure and Applied Chemistry which will meet in Philadelphia next April has been appointed the first incumbent of a new Cornell visiting professorship made possible by an anonymous gift of $250,000. From February to June he will lecture on the most recent advances of chemistry, and tell of his own original investigations in physical and inorganic chemistry which have won him international distinction.—*Science Service*

"Make Hay While Sun Shines" Proves Scientific Maxim. " 'Make hay while the sun shines' is more than a mere poetic slogan, for hay made in the dark is devoid of rickets-preventing properties."

This was the keynote of a discussion on the importance of light for the maintenance of animal life before the meeting of the National Academy of Sciences, by Drs. H. Steenbock and E. B. Hart of the University of Wisconsin.

The hitherto unappreciated importance of the ultra-violet radiation from the sun is now recognized, and this invisible light is known to be the factor deciding between success and failure in animal rearing, Dr. Steenbock said. Animals obtaining sufficient full sunlight, or the proper kinds of foods on which sunlight has shone, live healthily and normally; but, said Dr. Steenbock:

"Unfortunately these rays are not present in sufficient degree to provide a wide margin of safety for the animal. As a result we have rickets in the young and poor dentition, restricted lactation, abortion and impoverishment of the skeleton in lime to a dangerous extent in the adult. All of which appears to be of greater importance in animal welfare than has been generally realized."

The prevention of these dire results, in animals as well as in human beings, has been shown to depend on the normal action of the blood in laying down the element calcium in the proper places and sufficient quantities. This building of the limy parts of the body has in turn been shown to depend on the action of the invisible short-wave light rays, which may be administered directly or through certain types of food, especially those rich in cholesterol, a substance related to the fats.—*Science Service*

[3] "Onlooker," *Discovery*, **6**, 373–5 (1925).

ABSTRACTS

The Lazy High-School Student. J. J. BIRCH. *Educ. Rev.*, **70**, 210–2 (1925).—B. discusses the causes for the existence of the lazy high-school student and the usual corrective methods employed. He points out, however, that our schools are crying for a bit of human engineering to be mixed with its intelligence tests, its modern methods of teaching and its modern buildings. The task is salvaging human life—rescuing it during the plastic period of youth. H. K. M.

The Conditions of Chemical Change. H. E. ARMSTRONG. *Nature*, **116**, 537 (1925).—Chemical action of whatever kind is essentially electrolytic: consequently, change takes place only when the potentially interacting substances constitute an electrolytic circuit; such circuit appears always to be one of three components, of which one necessarily is an electrolyte. Attention is called to the controversy of Coehn and Tramm with Baker over the action of ultra-violet light on hydrogen and oxygen. After ultra-cleaning, ultra-purifying, and ultra-drying of vessels and contents the reaction should not occur and this is confirmed by Baker. H. K. M.

On the Advancement of Science by Published Papers. J. BELLING. *Nature*, **116**, 539 (1925).—B. gives sound advice on the writing of scientific papers in the briefest possible form and warns that the penalty will be cessation of publication except in the form of abstracts. The truth and nothing but the truth, but never the whole truth; one must omit trivialities. It is unethical for the research worker to advertise. Mere facts, however new, are often (though not always) of perceptible value only when some one has demonstrated their relations to other facts or to a theory or hypothesis. Repetitions and confirmations are of sufficient scientific interest to warrent publication only to a certain degree. The publication of a working hypothesis by one who has collected a sufficient amount of relevant facts is welcome, indeed almost necessary. But a mass of untested hypotheses is readily producible and may be aimless except to fill space. H. K. M.

The Worth of Knowledge. W. F. F. SHEARCROFT. *Nature*, **116**, 541–2 (1925).—S. desires a department of natural science in every university and school and would like to see the growth of the idea that no man—classic, historian, linguist, chemist—could claim to be educated who had not passed through its curriculum. The courses should be organized to present the aims, ideals, and methods of science. They should train the individual to think and act in a scientific manner. The professorial staff should be composed of men who could address an audience in a manner which will command attention or stimulate interest. H. K. M.

The Tensile Properties of Single Iron Crystals. H. C. H. C. *Nature*, **116**, 593–4 (1925).—A discussion of the work of Edwards and Pfeil compared with that of Carpenter and Elam. The tensile strength of single iron crystals is 50 to 75% that of the microcrystalline metal. This is well below the highest figure for single crystals of aluminum. H. K. M.

Valence Theories and the Magnetic Properties of Complex Salts. L. A. WELS AND O. BAUDISCH. *Nature*, **116**, 606–7 (1925).—W. and B. consider the number of electrons in certain levels associated with the central atom, and for the present purpose disregard the matter of orientation. The Kossel and Lewis-Langmuir valence theories are guides in determining the number of electrons which the central atom of the complex may obtain from or give to the groups or radicals in the compound. It is shown that iron with 26 electrons acquires 10 more making 36 in all and thus corresponds to the diamagnetic rare gas krypton. Considering the 64 cobalt compounds measured by Rosenbohm, all but two are diamagnetic. The two exceptions are so slightly paramagnetic that the magneton number may be taken to be zero. Disregarding the light of doubtful composition, in all cases the cobalt atom acquires 9 electrons and attains the krypton configuration of 36. So in other cases the configurations of Xenon, Niton, and Polonium are attained. H. K. M.

Apparently Anomalous Protection against Oxidation. S. E. SHEPPARD. *Nature*, **116**, 608–9 (1925).—In a technical investigation of the blackening of copper, brass, and bronze in potassium persulfate solutions it was noticed that when the strip of metal was dropped into the solution it blackened readily and completely. If, however, it was slowly lowered into the solution, blackening either did not take place or was very patchy and imperfect. When the metal is slowly lowered into the persulfate solution, it is exposed for a longer time to the air-solution interface. S. describes experiments to show that concentration of molecular oxygen in this layer causes the interference and the facts appear to demonstrate another case of the impedance of oxidation by oxygen. H. K. M.

The Chemistry of Solids. C. H. DESCH. *Nature*, **116**, 610–3 (1925).—"It is remarkable how little we know with any certainty about the chemical properties of solids, although the idea of a solid is so fundamental." D. gives a review of a large field presenting rather our ignorance than our knowledge. H. K. M.

The Isotopic Composition and the Atomic Weight of Chlorine in Meteorites. A. W. C. MENZIES. *Nature*, **116**, 643–4 (1925).—A letter in reply to Harkins and Stone under the above title in *Nature* of September 19. M. points out "that the matter is somewhat complicated by the question as to whether the rather small proportion of chlorine present is primary or secondary, that is, whether or not it is genuinely extra-terrestrial in origin." H. K. M.

Photochemical Problems. E. K. RIDEAL. *Nature*, **116**, 647–8 (1925).—Photochemical problems not only provide a common meeting-place for physicists, astronomers, and chemists but, as the botanists have long observed and the medical profession is now realizing, life is in great measure dependent on photochemical action. The first action of the light in producing chemical change is to undergo absorption by a molecule, thus converting it into an "activated" or "excited" molecule. It may fluoresce and thus lose its newly acquired energy by emission of radiation. It may collide with another molecule and the internal energy may be liberated in the kinetic form or be handed on to the molecule with which it comes in contact. The possibility of chemical reaction on collision is presented. It is little wonder that in many reactions the photochemical efficiency is low. In addition there exists an ever-increasing group in which the photochemical yield is much greater than is to be anticipated from consideration of the amount of light absorbed. Such reactions are designated as "chain" reactions and the various hypotheses as to their mode of action are at present a matter of heated controversy. The leading hypotheses are briefly outlined. H. K. M.

The Determination of Traces of Mercury. H. S. BOOTH AND NORA E. SCHREIBER. *J. Am. Chem. Soc.*, **47**, 2625–9 (1925).—A rapid method for the qualitative detection of traces of mercury, far surpassing in sensitivity the tests usually employed, is described. Methods for making the best of the older tests are first given. A table is then presented, showing the utmost limit of sensitivity of eleven colorimetric and eight microchemical tests. The conclusion arrived at from the table is that no test heretofore employed is sensitive beyond a dilution of 5 parts per million.

The authors then describe their new test, which is shown to be sensitive to one part in two million and, after isothermal concentration, to 1 part per billion. It consists in employing the depression in an ordinary microscopic "Culture" slide as an electrolytic cell. To the slide a 36-gage copper wire is fastened with de Khotinsky cement and its free end polished to a fine point. This serves as the cathode. A small platinum wire similarly mounted is the anode. Both are connected to heavier wire and a source of current. One drop of the solution, acidified with nitric acid, is placed in the depression, the Pt wire placed in it and the tip only of the Cu wire. A current of 1.3–1.5 milliamperes and 1.5–2.0 volts is passed for two to three minutes. Microscopic examination easily shows the presence of mercury on the copper wire. By preliminary concentration by isothermal distillation in a desiccator over sulfuric acid, the test becomes easily sensitive to 1 part per billion. A. P. B.

A Comparison of the Lecture-Demonstration and the Laboratory Methods of Instruction in Science. E. R. DOWNING. *Sch. Rev.*, **33**, 688–97 (1925).—A collation and discussion of published papers and master's theses bearing on the subject. The author finds this summary: "The lecture-demonstration method of instruction yields better results than the laboratory method in imparting essential knowledge and is more economical of time and expense. This is true for both bright and dull pupils and for all types of experiments. The last two points need additional experimental confirmation.

"The lecture-demonstration method appears to be the better method for imparting skill in laboratory technique in its initial stages and for developing ability to solve new problems. Again, these two items are tentative conclusions and further experiments will be required to establish them.

"Oral instructions are, in general, more effective than written instructions in lecture demonstration but less effective in laboratory work.

"What the experiment proves is the item on which most pupils fail and is evidently the point to be stressed in teaching.

In science teaching we need to concentrate on a few fundamental principles and to curtail the multiplicity of details in order that pupils may retain the instruction. 'Teach for Keeps' must be the slogan."

The execution of the method seems to be the main determining factor rather than the difference of method. H. R. SMITH

Mechanism and Vitalism. J. ALBERT HALDI. *Monist,* **35,** 590–604 (1925).—A criticism of Loeb's "Regeneration." T. G. T.

An Electromagnetic Theory of Matter, Life, and Mind. OLIVER L. REISER. *Monist,* **35,** 605–32 (1925). T. G. T.

A Scientist's God. SAMUEL GROWTHER. *Colliers,* **76,** No. 17, 5 (1925).—An interview with Robert Andrews Millikan in which he is quoted as saying:

"Let me, henceforth, use the word God to describe that which is behind the mystery of existence and that which gives meaning to it. I have never known a thinking man who did not believe in God.

"I am chary about declaring that our present scientific conceptions and hypotheses are going to last forever and I am a good deal more chary about making dogmatic denials and affirmations in the field of religion, a field which by general assent lies outside the region in which intellectual knowledge is possible.

"This much I can say with definiteness—namely, that there is no scientific basis for the denial of religion nor is there in my judgment any excuse for a conflict between science and religion, for their fields are entirely different. Men who know very little of science and very little of religion do, indeed, get to quarreling and the onlookers imagine there is a conflict between science and religion, whereas the conflict is only between two different species of ignorance.

"The purpose of science is to develop without prejudice or preconception of any kind a knowledge of the facts, laws, and processes of nature. The even more important task of religion, on the other hand is to develop the consciences, the ideals, and the aspirations of mankind.

"Without the moral background of religion, without the spirit of service which is the essence of religion our new powers will only be the means of our destruction."

J. W. HOWARD

Poison Gas for Home Use. WILLIAM G. SHEPHERD. *Colliers,* **76,** No. 16, 11 (1925).—Comments on sections quoted from "Provisional Instructions for the Control of Mobs by Chemical Warfare. Nov. 21, 1921. Revised to Aug. 1, 1922."

The article brings out the fact that there are three types of mobs with corresponding instructions for handling each either by land or air forces. It is a protest against the use of gas for this purpose. J. W. HOWARD

Educational Values Derived from the Teaching of Science in the Elementary School. CLIFFORD WOODY. *Am. Educ.,* **29,** 60–7 (1925).—Since the time of Rousseau, Pestalozzi, and Herbert Spencer up to the present time there has been much interest in the teaching of subjects of scientific nature in the elementary school. Today, about one-tenth of the total teaching time is spent on scientific and related subjects. Of the values to be obtained from the teaching of science in Grades I to VI the following are given: 1. It equips the child with a varied and extensive vocabulary. 2. It provides opportunity for giving the children significant experiences in connection with the life with which they are surrounded and about which they are going to read. If significant experiences could be provided for much of the subject-matter constituting the regular course of study, it could be more thoroughly mastered in much less time and would be retained much longer. 3. The teaching of science in these grades provides for the training of the children in the methods of thinking and in the development of scientific attitudes. The very nature of the subject-matter of science lends itself to the mental processes of thinking, for the student must collect data, organize and evaluate it for analysis, comparison, and contrast, for seeing likenesses and differences in the relation of cause and effect, and for setting up hypotheses. 4. The teaching of science in these grades offers opportunities for utilizing the natural interests of the boys and girls as centers around which much of their other work may be unified. Contrary to popular belief in some quarters that the children prefer highly colored, imaginary stories to the truthful nature story, it has been shown that this is not the case. It is ventured that when the proper type of nature stories is available and when teachers are properly trained for teaching elementary science there will need be no fear about the interest of the boys and girls in the subject. If the natural interests of the pupils are in science subjects, such subjects may well be used as the core around which other instruction may be built. V. K.

Detection of Nitric Acid and Nitrates in Concentrated Sulfuric Acid. JAMES WILSON. *Chem. & Ind.,* **44,** 438 (1925).—1:5 Dihydroxyanthraquinone is a very sensitive indicator for detecting the presence of nitric acid in concentrated sulfuric acid. The indicator when dissolved in concentrated sulfuric acid free from nitric acid gives a bright red solution. If a trace of nitric acid is present a distinctly yellow coloration is obtained.

It was found that 0.004% by weight of nitric acid in 100 cc. of sulfuric acid can be detected. In 100 grams of sulfuric acid 0.002% by weight of nitric acid can be detected. The test is more sensitive than the well-known "brown ring" test and is easier to perform. In the presence of a halogen the "brown ring" test is by no means reliable. Details of the test, which can be applied also to soluble nitrates and nitrous acid, are as follows:

A solution or suspension of the suspected material in concentrated sulfuric acid is prepared so as to contain not less than 0.002% of nitric acid. To 10 cc. of this solution one drop of the standard indicator is added, prepared from 0.2126 gram of 1:5 dihydroxyanthraquinone dissolved in 250 cc. of sulfuric acid (A. R.). After standing for about one minute the color is observed and compared with a similar quantity of sulfuric acid and one drop of the indicator. The color change from red to yellow indicates the presence of nitric acid. W. R. W.

Electronation. HAMILTON P. CADY AND ROBERT TAFT. *Science*, **52**, 403–4 (1925).—The terms oxidation and reduction as applied to chemical reactions have come to mean more than the simple addition or removal of oxygen or of hydrogen to or from a substance, although many chemists and text-books of general chemistry still attempt to explain all oxidation-reduction phenomena in terms of these two elements. One of the most powerful arguments against this prevailing practice is that oxidation can take place in the absence of oxygen and that reduction can take place in the absence of hydrogen. One familiar case that the student of general chemistry will recall is that ferrous chloride can be oxidized to ferric chloride by free chlorine. Certainly there is no oxygen here and yet this is a type of reaction that all chemists agree is oxidation.

Other terms have been suggested to cover the general phenomena of oxidation; Richards some years ago suggested the word "perduction" and somewhat later Getman suggested the word "adduction;" the term reduction was to be retained. Within the last few years Franklin has shown that reactions similar to oxidation and reduction take place in liquid ammonia. He calls changes of this type "nitridations." For example, hydrazoic acid, NH_3, is a nitric acid of the ammonia system of compounds and as such serves as a nitridizing agent. Other terms have been suggested but have failed to be adopted generally. The authors suggest the term "electronation" to cover the general phenomenon. Their reasons for this are as follows:

(1) At the present time the electron theory is exceedingly popular and it should not, therefore, be difficult to introduce the term into the literature and text-books.

(2) There already exists in many text-books of general chemistry a definition of oxidation and reduction in terms of electrons. To state it in terms of the word used by the authors, "Electronation is the addition of an electron or electrons to an element; de-electronation is the removal of an electron or electrons from an element."

(3) By using these terms the explanation of the phenomenon is freed entirely from any assumption that oxygen and hydrogen are involved, an assumption which is very common and quite erroneous. W. R. W.

International Scientific Relations. W. A. NOYES. *Chem. Bull.*, **12**, 251 (1925).—The history of International scientific societies is sketched from the organization of the International Research Council in 1918, which did not include the Central Powers, through the recent meeting of that Council at Brussels, July 7–9, 1925. Mention is made of the International Council of Chemical Societies which met 1912 and 1913, at Berlin and Brussels, respectively, and that was to have met at Paris in 1914. After the war, about 1920, an International Union of Pure and Applied Chemistry was formed in connection with the International Research Council.

At the meetings of this Union in 1922, at Brussels; in 1923 at Cambridge; and in 1924 at Copenhagen; efforts were in evidence looking toward the admission of Germans to the Union. Finally after the general acceptance of the Dawe's report it was felt that the time had arrived for the amendment of the statutes of the International Research Council permitting any nation which is a member of the League of Nations to be admitted to the Union. At a meeting of the Union at Bucharest, June, 1925, a motion that the statutes of the International Council be changed as suggested was carried unanimously.

When the International Research Council met in Brussels, July 7–9, 1925, the amendment suggested by the Chemical Union gave place to one to remove all political restrictions to membership. This plan even though in much more favor than the former failed of passage for lack of the two-thirds majority required. The representatives from twelve nations having twenty-four votes were absent so that a unanimous vote of those present would have been necessary for the passage of the amendment.

The author feels that the measure was defeated by the feeling of distrust in the minds of the French, Belgian, Polish, and Czecho-Slovakian delegates for the scientific men of Germany. He also thinks that the horrors of the Great War in the minds of those who actually fought in it will lead them, when they come into power, and they will be these nations' leaders during the next twenty-five years, to substitute judicial settlement of international controversies for war.

The International Research Council's failure to take action has aroused strong protests and an endeavor is under way to secure a special meeting of the council or a letter ballot in the near future. The A. C. S. at its fiftieth meeting next September should lead in this movement by resuming friendly relations with the Germans.

B. CLIFFORD HENDRICKS

Research in American Colleges. M. M. METCALF AND C. E. MCCLUNG. *Bull. Am. Assoc. Univ. Prof.*, **11**, 300 (1925).—Conferences and discussions under the general auspices of the Division of Educational Relations of the National Research Council led to the appointment of a committee for forwarding the project of more "productive scholarship among teachers in American colleges."

M. M. Metcalf, chairman of this committee regrets that "our whole educational system has in it the constant tendency to restrain the expression of individual initiative. The university has to overcome this and help the student develop the habit of independent thinking and self-directed contribution to society." "To get the best teaching in college we must help the teachers themselves to be productive in their own fields."

C. E. McClung, one of the committeemen suggests: Teachers must be supported as well as encouraged in this original work by the administration of the college. Time for such work should be definitely assigned and its use for that purpose jealously protected. It is not primarily desired that the output of research be increased so much as that the spirit of originality in the teacher and pupil be fostered. This means that, in large part, the work involved be done in the college. Many detailed suggestions to consummate the desired ends are given. "Effort for promotion of research among college teachers is very closely related to the effort to advance the interest of the gifted student. . . . .(This movement) endeavors to quicken the intellectual life of the teacher for the sake of the stimulus which will thus pass to the pupil. The better care of the able student will also be a stimulus to the teacher."

B. CLIFFORD HENDRICKS

Ethylene Glycol—A Contribution of Chemistry to the Automobile Anti-freeze Problem. G. O. CURME, JR. AND C. O. YOUNG. *Ind. and Eng. Chem.*, **17**, 1117–20 (1925).—It is entirely possible that chemical industry may shortly make an important contribution to the convenience and efficiency of the winter use of automobiles. Safeguarding of radiators from freezing, a function of obviously great importance, has hitherto been accomplished chiefly by addition of ethyl alcohol, denatured with methyl alcohol, to the cooling water used in the motor. A mixture is thus produced which will not freeze at temperatures usually encountered. Use of the ethyl-methyl mixture has two serious disadvantages. First, the composite liquid boils at a much lower temperature than pure water, entailing large losses of alcohol through evaporation and keeping the motor at a temperature below that required for greatest efficiency of operation. Second, the methyl vapors evolved when the radiator boils have an objectionable odor, are inflammable, and tend to injure certain types of automobile finishes. Research aimed at finding a better anti-freeze substance has resulted in the development of a commercial process for the manufacture of ethylene glycol (CH_2OHCH_2OH), which seems to have all the properties desirable in a liquid to be used for inhibiting freezing. This compound is non-inflammable, non-corrosive to metals, and harmless to lacquers used in automobile finishes. A water solution of ethylene glycol has a lower freezing point than a water-alcohol solution of the same concentration. Since the glycol has itself a very high boiling point, its aqueous solution has a slightly higher boiling point than pure water, and what is more important, very little of the antifreeze substance is present in the vapor. Consequently, the material is not lost through evaporation, and no objectionable odors are present. Ethylene glycol appears to be an efficient, non-injurious, and permanent anti-freeze compound. The authors assert that the automobile trade could be cheaply supplied.

V. R. THAYER

Uses for a Broken Electric Light Bulb. RALPH T. TEFFT AND D. J. BROWN. *Ind. and Eng. Chem.*, **17**, 1201 (1925).—The two wires that conduct the current through the glass to the filament of most nitrogen-filled electric light bulbs are a convenient substitute for ordinary platinum wires. They may be sealed into glass for conductors, as in the calomel electrode, or may be used with glass rods for the ordinary flame tests. They are unsuitable, however, for bead tests.

V. R. THAYER

Across the Table. W. LEE LEWIS. *Chem. Bull.*, **12**, 261 (1925).—The abstractor

assays this article with some considerable trepidation. The author's inimitable style cannot be reproduced and that is no small part of the article's appeal. However, the theme is timely, namely, the desirability of finesse as well as intellectual scope and accuracy in the training of young chemists. The message is unfolded by dialogue in which the "professor," the "patriarch," and others participate. Some quotations may best indicate the bent of the conversation.

"I tell you, gentlemen, information without sentiment is the curse of our day. They (these young men) seem to essay a fine disdain for the gentler things of life, thinking, somehow, it throws their more rugged intellectual qualities into bolder relief."

"Do you know a young chemist in our section who reads Dickens?" "Or doffs his hat in an elevator of ladies?" "Or knows Tennyson?" "Or pays his respects to the chaperones at a party?" "Or manifests a respect for his employer?" "Or walks alone and thinks in the twilight?" "Or takes an occasional philosophical wallow in the cosmos?"

"The Patriarch is right; consideration for others and a gentle manner are the true tests of culture and a clean hobby keeps the soul alive."

The Professor remarks "Out at our school we have a slogan, 'Be a chemist-plus.' We are trying to train our boys to be chemists and gentlemen."

B. CLIFFORD HENDRICKS

Objectives of Science in Secondary Schools (Editorial). *Sch. Rev.*, **33,** 651 (1925).—An editorial quoted from the *London Times.* "The best teaching depends on the teacher rather than on the elaboration of the machinery for teaching. It has been the complaint in the technical colleges that the practical science teaching in the secondary schools has, in many cases, been so inefficient and so misleading that the whole of the work has had to be unlearned before practical progress could be made. The curriculum of secondary schools necessarily has had to be enlarged in the past half century, but the trouble to which the enlargement of the curriculum has led is that every pupil is expected to have a scrappy knowledge of many unrelated subjects and fails to secure an exhaustive knowledge of fundamental elementary subjects. That is why eminent men in the university grade of technical education are tempted to look askance at the products of science teaching in secondary schools. The pupils from these schools who pass to the technical colleges have been through a science course which they were not fit to enter. They have not been trained to think and to love knowledge for its own sake. It can come only from a liberal and a thorough preparatory education."

Of the 1461 pupils in physics and chemistry who passed the examinations of the Oxford and Cambridge Board only 616 passed with credit. In other sciences a half to a tenth passed with credit. H. R. SMITH

The Structure of the Atom. P. H. ABRIGHT. *Sch. Sci. & Math.*, **25,** 823–7 (1925).—An outline of the theory by Neils Bohr, University of Copenhagen. H. R. SMITH

The Conduct of Laboratory Work in Elementary Chemistry. W. G. BOWERS. *Sch. Sci. & Math.*, **25,** 828–32 (1925).—The beginning experiments should have close supervision to prevent bewilderment of pupils, but it should not take the form of personal assistance. The laboratory should be free from distracting noises. This supervision should keep the pupil's mind on definite lines of thought leading to principles. "Make questions such as will call forth reasoning instead of memory. Men of judgment will get information from reliable sources and solve problems. Men of information and not power of reasoning will have a life full of errors." Education should prevent errors in life. H. R. SMITH

Objectives of High-School Chemistry. S. R. POWERS. *Sch. Sci. & Math.*, **25,** 832–3 (1925).—Thirteen statements of the social values to be obtained by the study of chemistry. A compilation from various sources. H. R. SMITH

Science and the Medium. HUDSON HOAGLUND. *Atlantic Mo.*, **136,** 666–81 (1925).—Our excuse for considering this article is that Hoaglund is a trained chemical engineer, and that he has written, in excellent literary style, an account of the triumph of scientific methods in solving the mysterious manifestation of teleplasm which has baffled so many investigators and which has given the medium so much newspaper notoriety in the past few years. Since this is a mystery story, one must read the article for the solution. SCARLETT

On the Molecular Scattering of Light in Liquids. K. S. KRISHNAN. *Phil. Mag.*, **50,** 697–715 (1925).—Measurements are given for the intensity and imperfection of polarization for different regions of the spectrum produced by light transversely scattered by 65 different dust-free liquids, mostly organic compounds. Some of the liquids showed slight fluorescence. The relation between the depolarization and chemical constitution is shown. T. G. T.

Note on the Theory of Interionic Attraction in Strong Electrolytes. S. R. PIKE AND G. NONHEBEL. *Phil. Mag.*, **50,** 723–8 (1925).—A study of the equations of Milner and of Debye and Hückel for the behavior of strong electrolytes in solution. T. G. T.

The Activity Coefficients and Transport Numbers of Solutions of Hydrogen Chloride in Methyl Alcohol. G. NONHEBEL AND H. HARTLEY. *Phil. Mag.*, **50,** 729–49 (1925).—Activity coefficients of hydrogen chloride in methyl alcohol, ethyl alcohol, and water agree fairly with the calculated values from Milner's equation of interionic electrical energy in a completely dissociated solution of an electrolyte. Debye's equation does not apply.

The partial pressure of hydrogen chloride over its solution in one solvent may be calculated from the pressure over a second solvent and a series of measurements of the e. m. f. in both solvents. T. G. T.

Regeneration in Tuned Three-Element Vacuum-Tube Circuits. E. H. LANGE. *Phil. Mag.*, **50,** 750–60 (1925). T. G. T.

Ionic Equilibria across Semi-Permeable Membranes. N. KAMEYAMA. *Phil. Mag.*, **50,** 849–64 (1925). T. G. T.

On the Attachment of Electrons to Gas Molecules. V. A. BAILEY. *Phil. Mag.*, **50,** 825–43 (1925). T. G. T.

Painleve Succeeds Bergson as International Science Head. M. Paul Painleve has been appointed president of the League of Nations Committee for International Intellectual Coöperation to succeed M. Henri Bergson, whose ill health has compelled his retirement. Professor Rocca, of the University of Rome, has also been appointed to succeed Senator Ruffini as a member of the committee.—*Science Service*

Disinfectants Need More Standardization. There are all kinds of germs, strong and weak, hard-headed and easy-going. When you put a disinfectant on a cut, you may kill some germs, but not even frighten others. Disinfectants vary greatly in their efficiency, some being good for one thing and some for another.

Dr. G. F. Reddish, bacteriologist of the U. S. Department of Agriculture, declares that the science of disinfection is still in a primitive state, and that it needs complete overhauling and standardization. Practically all the disinfectants in common use are standardized by comparing their efficiency as germ killers to the disinfecting power of carbolic acid on one special type of organism alone, the typhoid bacillus.

Typhoid bacilli are weaklings among germs and are more easily killed by disinfectants than many of the more hardy types. Not only that, but some disinfectants show a peculiar antipathy for certain organisms while they spare others. Pine oil, for example, kills the typhoid bacillus, but does not harm Staphylococcus aureus, the most common cause of boils and abscesses.

"Such hit and miss disinfection is the rule at the present time," Dr. Reddish said. "Our disinfectants are undoubtedly good in their place, but their place must be determined. All of our disinfectants should be subjected to a thorough study to determine their best uses. They should be tested against many organisms, both strong and weak, instead of against the typhoid bacillus alone, as they now are."

Dr. Reddish suggests a list of seven disease-producing organisms which he thinks offers a wide enough range for testing the special abilities of disinfectants, such organisms representing the most common bacteria which produce disease. The organisms recommended are those which cause typhoid fever, diphtheria, pneumonia, tuberculosis, plague, boils, and blood poisoning.

"Although this scheme of classifying disinfectants will undoubtedly have its difficulties, it nevertheless seems to be the most logical step forward," Dr. Reddish adds.—*Science Service*

Local Activities and Opportunities

Stanford University. Dr. George B. Frankforter, professor of chemistry in the University of Minnesota, is spending the present academic year at Stanford University as acting professor of chemistry. He is offering lecture courses in general inorganic chemistry and in the chemistry of explosives and dyes.

Dr. Robert E. Swain, professor of chemistry at Stanford University, has just completed a series of five public lectures at the University of Arizona on recent contributions of biochemical research to human welfare, as visiting lecturer at that institution.

C. A. C. T. The Chicago Association of Chemistry Teachers held a sectional meeting, November 20th, at which Prof. J. H. Walton of the University of Wisconsin spoke on the topic, "Some Problems of the General Chemistry Teacher." His remarks were confined chiefly to the problems in laboratory instruction.

University of Arizona. On November 12th, Mr. C. N. Catlin, associate professor of agricultural chemistry, died following an operation for appendicitis. Professor Catlin had been at the University since 1912 and has published a number of bulletins on various phases of soil chemistry.

During the past summer Dr. Margaret L. Cammack was appointed associate professor of home economics. For some years Miss Commack has been an instructor in biochemistry at Columbia University where she secured the Ph.D. degree for work with Dr. Sherman. At the University of Arizona Dr. Cammack will have charge of the nutrition work in the department of home economics.

During the week of November 2nd, Professor R. E. Swain, of Stanford University, gave a series of five lectures on Biochemistry and Human Welfare before the department of chemistry and the Arizona Section of the American Chemical Society.

Research work in various lines of chemistry is being actively conducted at the University of Arizona. In agricultural chemistry, Dr. P. S. Burgess and his associates are studying the effect of irrigation waters on the soils of the State. Already a number of bulletins have appeared from the Arizona Station on this problem and others are soon to appear. Studies on vitamins have been begun by Dr. Margaret L. Cammack of the department of home economics and it is expected that this work will yield interesting results in the near future. Dr. T. F. Buehrer and Mr. O. E. Schupp have just published an article on the electrometric titration of copper and iron. Dr. Buehrer and Mr. Earl Roseveare are just completing a determination of the potential of the gold electrode. Dr. L. E. Roberts has, for the past year or more, been studying the influence of the composition of the slag and copper losses in smelting. This work will be ready for publication early in the coming year. Professor Anderson and Dr. Lila Sands have recently published two articles dealing with some plant gums that occur in the Southwest. This work is being continued.

It is very encouraging to note that the Administrative Officers are giving every possible aid to research at the University.

Nebraska. Royce Le Roy, assistant instructor in the department of chemistry, has been called, upon two different occasions, to Lincoln's largest Junior High School to talk to the general science classes. Subjects used were: "What Is a Chemist?" and "Why Study Science?"

Chemistry is entering the list of extension courses in Nebraska. Doctor T. J. Thompson of the University of

Nebraska is offering such a course to nurses-in-training in various Lincoln hospitals; Mr. J. H. Dorsey of the Northside High School in Omaha is offering a similar course to nurses-in-training in Omaha hospitals and Dr. B. Clifford Hendricks is preparing a course, "Teachers' Methods for High-School Chemistry" for use by teachers in service and to be offered through the University extension division.

Doctor T. J. Thompson, local committeeman for the Garvan essay contest, has actively brought the contest before the public in many ways. He appeared before the science teachers in one of the district teachers' meetings, he has found the press very responsive and his "Garvan Prize Essay" was one of the high school convocation talks recently broadcasted through the University of Nebraska station.

Professor Howard A. Durham, chairman of the chemistry department of Nebraska Wesleyan University, is chairman of the all-state section of science teachers of Nebraska. This group usually meets at the same time as the delegate assembly of the Nebraska State Teachers' Association which held its last meeting on December 10th.

University of California. Professor W. C. Morgan, chairman of the department of chemistry at the Southern Branch of the University of California and general chairman of the Los Angeles meeting of the American Chemical Society, has recently been reëlected president of the local section of the American Chemical Society.

Columbia University. Professor James Kendall, of the department of chemistry, delivered a lecture on "The Rare Earths" at the School of Chemistry of the University of Minnesota at Minneapolis on December 1st. On December 5th he spoke on the same topic before a joint meeting of the New England Association of Chemistry Teachers, the Chemistry Teachers' Club of New York City, and the New Haven Section of the American Chemical Society at Bridgeport, Conn.

C. A. S. M. T. The Chemistry Section of the Central Association of Science and Mathematics Teachers held its two sessions at the University of Chicago during the Thanksgiving Holidays. The following papers were read at the meeting and will be published for the most part in *School Science and Mathematics* about February, 1926.

"Application of Absorption Spectra to the Solution of Problems of Inorganic Chemistry"—Dr. H. I. Schlesinger, University of Chicago.

"Artificial Silk"—Miss Weirick of Sears, Roebuck & Co.

"The Scientific Background of Baking"—C. B. Morison, American Institute of Baking.

"Cement"—D. I. Elder, Universal Portland Cement Co.

"Methods in the Teaching of Chemistry"—Chas. J. Pieper, University of Chicago, The School of Education.

"Recent Work on the Ether-Drift"—Dr. Dayton C. Miller, Case School of Applied Science, Cleveland, Ohio, President of the American Physical Society.

"Survey of Recent Progress in Botanical Research"—Dr. Merle Coulter, University of Chicago.

"Demonstration of Atom Collisions"—W. O. Haskins, the University of Chicago.

"The General Science Course"—Chas. H. Lake, First Assistant Superintendent of Schools, Cleveland, Ohio.

New York University. A gift of $600,000 has been made to New York University by the Nichols Foundation through Dr. William H. Nichols. Dr. Nichols is a graduate of New York University of the class of 1870, having studied chemistry at this institution under Professor John W. Draper. He is well-known as the former head of the General Chemical Company and of other chemical corporations, as former President of the American Chemical Society, and as present Chairman of the Board of Directors of the Allied Chemical and Dye Corporation. The gift is to be used for the construction of a new chemical laboratory on the fifty acre

campus of New York University at University Heights, replacing the present Havemeyer Chemical Laboratory. In it will be given chemical courses of the undergraduate College of Arts and the College of Engineering, and research work of the Graduate School. Plans are now being considered by a building committee consisting of Dr. William H. Nichols, General John J. Carty, Mr. LeRoy E. Kimball of the Council and Professors Author E. Hill and Collins P. Bliss of the faculty.

Teaching fellowships at the New York University are open for the second term of this year, beginning February 1st. These are intended primarily for men interested in graduate work toward a high degree. The fellowships will pay $400 for the second term and the holders will be considered for reappointment on a yearly basis. In order that the time of the fellow shall be largely free for graduate work, the teaching requirement is limited to six to eight hours of class room assistance per week.

S. D. E. A. At the annual meeting of the South Dakota Education Association held at Mitchell, South Dakota, November 23rd–25th, inclusive, the following program was presented in the Physics and Chemistry Round Table:

"Theme—How We May Improve Physical Science Teaching in South Dakota."

"What the American Chemical Society Is Doing to Render High-School Chemistry More Efficient"—Dr. A. M. Pardee, State University.

"Aims in H. S. Physics"—John H. Clouse, Physics Dept., Sioux Falls High School.

"High-School Chemistry Club"—Harold Walker, Rapid City High School.

"Garvin Prize Essay Contest"—Dr. B. A. Dunbar, State College.

"A Laboratory Course in Physics"—R. H. Drug, Physics Dept., Deadwood High School.

"Present Condition of High-School Science Work in South Dakota"—Prof. J. H. Jensen, Northern Normal and Industrial School.

"Chemistry and the World View"—Prof. D. C. Farley, State College.

"New Type Examinations for Physics"—B. V. Stanley, Mitchell High School.

"Use of Industrial Exhibits in Science Instruction"—Prof. R. E. Dunbar, Dakota Wesleyan University.

"Chemical Open House as an Aid in Chemistry Instruction"—Prof. F. T. Doane, Dakota Wesleyan University.

For the coming year the following officers were elected:

President, Arthur M. Pardee, Chemistry Department, State University, Vermillion, S. Dak.; Vice-President, Harold Walker, Rapid City High School, Rapid City, S. Dak.; Secretary-Treasurer, R. E. Dunbar, Dakota Wesleyan University, Mitchell, S. Dak.; Executive Committee, J. H. Jensen, Northern Normal and Industrial School, Aberdeen, S. Dak.; H. B. Matthews, State College, Brookings, S. Dak.

University of Chicago. At a luncheon tendered to friends of the University of Chicago by the department of chemistry and the University on December 5th, Dr. William Mayo, of Rochester, Minnesota, spoke on "The Importance of Chemistry in Connection with Progress in Medicine" and Dr. A. D. Little of A. D. Little, Inc., spoke on "The Relation of Chemistry to Industry."

At the Autumn Convocation, Tuesday, December 22nd, Messrs. I. M. Levine and S. B. Stone, and Miss Clara DeMilt received the doctorate degree and Messrs. T. H. Baker and Woods the M.S. degree. Dr. DeMilt returns to Newcomb College, New Orleans, La., as head of the chemistry department. Dr. Levine has accepted a research position with the Universal Oil Products Company. Mr. Baker has also accepted a position with the Universal Oil Products Company.

J. S. Morgan, Ph.D., Sept., 1925, holds a position in the Research Laboratories of the Delco Company, Dayton, Ohio.

Louis Sattler, Ph.D., Sept., 1925, is instructor of chemistry at the College of the City of New York.

Ruby K. Worner, Ph.D., Sept., 1925, is on the Faculty of the Oklahoma College for Women, Chickashaw, Oklahoma.

William G. Friedemann, Ph.D., Sept., 1925, is acting chief chemist at the Georgia Agricultural Experiment Station.

Agnes Sanders, M.S., Sept., 1925, is on the faculty of Hollins College, Virginia.

Arthur P. Locke, Ph.D., 1922, has been reappointed to the Seymour Coman Fellowship in Medical Chemistry for the third year.

University of Pittsburgh. Professor Alexander Silverman, head of the department of chemistry, lectured before the Maine Charitable Mechanic Association, Portland, Maine, December 30th, on "Glass, One of Man's Blessings."

Cornell Section, A. C. S. At a meeting of the Cornell Section of the A. C. S. held in Baker Laboratory at Cornell University, December 9th, Prof. G. W. Cavanaugh spoke on "Some Relations of Chemistry to Agriculture."

Union College. Dr. Ellery, Dean of the Faculty of Union College, Schenectady, N. Y., who, along with Mrs. Ellery, is at present on a visit to England recently visited the Universities of St. Andrews and Aberdeen where he delivered an address on the "Universities of America." The address was illustrated by means of lantern slides and was listened to with great interest and appreciation.

University of Arkansas. A chlorine clinic is being conducted daily in the University Infirmary, under the direction of the University physician, Dr. A. A. Gilbert. A recent report of the work states: "The treatment is becoming more popular with the students than it was at the beginning, because it produces results."

New Claim for Discovery, Missing Element 75. The missing chemical element number 75 has been discovered by Dr. J. Heyrovsky, professor of physical chemistry of Charles University, Prague, and Doctor Doleysek of the Prague Academy of Sciences, according to reports reaching London.

The element has been named bohemium, in honor of Bohemia, and was discovered as an impurity in the well-known metal magnesium through the use of the mercury drop electroscope.

Prof. Heyrovsky was a pupil of the famous English chemist, Ramsay, who discovered several elements, including argon.

Element 75 has heretofore been known only by its number or order in the table of elements arranged according to their atomic structure.

The discovery of element 75 is also claimed by Prof. Walter Naddack of the University of Berlin working with Otto Berg and Ida Tacke. On June 17 a *Science Service* dispatch from Berlin told how they had identified both numbers 43 and 75, known to be closely related, through the use of X-ray analysis and spectra. They selected the names rhenium and masurium as the elements 75 and 43, respectively, in honor of regions lost to Germany as a result of the war.

From the arrangement of the chemical elements based on laws developed by Moseley, the English physicist killed at Gallipoli, the properties of missing elements can be predicted. From such theoretical evidence it is known that elements 43 and 75 should be closely related and that they should also have physical and chemical properties allied to manganese.

If one or the other of the two claimants for the honor of occupying niche 75 in the array of fundamental stuff of the universe is successful, and if element 43 has been discovered as claimed, only three missing chemical elements will remain to be discovered. These are numbers 61, 85, and 87.—*Science Service*

Recent Books

The Elements of Chemistry. WILLIAM FOSTER, A.M., PH.D., Professor of Chemistry in Princeton University. D. Van Nostrand Co., 8 Warren St., New York City. First edition, 1925. xvii + 576 pp. 237 figures + 24 full page pictures of eminent chemists. 14.5 × 21.5 cm. $2.00.

"This text-book is intended for students beginning the subject. . . .An attempt has been made to tell the story of chemistry in simple and direct language, and gradually to blend theory with facts, in order that the student may not become confused. While great stress has been laid upon the numerous important applications of the science, the author is one of those who believes that a thorough course in chemistry is based upon fundamental principles. This is the only way to discipline the mind and to lay a broad and solid foundation. It should always be borne in mind that 'science is a method and not a collection of facts'. . . .A study of the gas laws, which are somewhat difficult for beginners, is postponed until Chapter XV," after lowering of the vapor tension of a solvent, elevation of boiling point and depression of freezing point have been treated.

The preceding quotations from the preface present the author's aims and purposes. Though apparently intended for high-school use, the text contains the material usually given to a beginning class of college students. The author has "told the story of chemistry" in an interesting manner and stressed its industrial applications, this being the outstanding feature of the book. The order followed is quite unusual yet the author's handling of the earlier chapters leaves one unconvinced of the value of the innovation. Science is organized knowledge: by organization we mean such an orderly arrangement of facts that it may be helpful in gaining further knowledge. Introducing Chapter VI, the author says, "As bases, acids, and salts are involved in the preparation of hydrogen, they will receive brief consideration before the study of this element." Then follows a description of bases, their uses, two pages of soap making, then acids, neutralization, salts and salt mining, all in seven pages. One can more readily understand the usefulness of soap making and salt mining for the purpose of "selling chemistry" to the students than as an introduction to the preparation of hydrogen or as an illustration of the organization of scientific material.

To a considerable extent fundamental principles are presented in chunks by themselves. Little reference is made later in the book to their application and there is none of the "rub it in" element.

A great variety of material is presented. There are figures of atoms with hooks to illustrate valence bonds and figures of the Bohr and the cubical atoms. In the index there is one reference each to chemical equilibrium and explosives, each topic being handled in two pages. The author sets forth a varied menu for the student with little indication of relative vitamin or calorie content or food value. He has in no way shown the student how to find his own food, prepare it, and use it that he may grow by his own effort. Aside from the statement in the preface, he has not led the student to realize that "science is a method and not a collection of facts."

W. C. MORGAN

Laboratory Exercises in General Chemistry. WILLIAM FOSTER, A.M., PH.D., Professor of Chemistry in Princeton University and HARLEY WILLIS HEATH, Head of the Science Department, Lawrenceville School. D. Van Nostrand Co., 8 Warren Street, New York City. First edition, 1925. vi + 186 pp. 30 figures. 14 × 20.5 cm. $1.25.

"These Laboratory Exercises are designed to accompany Foster's Elements of Chemistry. . . . The aim has been to outline a well rounded laboratory course. . . .for students who have had no previous training in chemistry." The manual contains a good assortment of the material usually found in books of this class. More is presented than can be covered in one year's work and intelligent choice is called for on the part of the teacher. Two pages of "Treatment in Case of Accident" are given in the front of the book where it is constantly called to the attention of students and always available during the excitement caused by an accident.

The first four exercises on The Metric System, Density, The Bunsen Burner and Glass Working, and some Common Operations are presented without objective other than their intrinsic value and the making of a wash bottle. Clever pedagogy would incorporate these points in some project with more inspiration. References to the text given in the order in which they appear in the manual are to pages 83, 344, 116, 2–8, 28–41, 164. A longer series shows the same jumping about. Apparently the arrangement of the text or the manual or both could follow some more natural or logical order.

Scattered through the manual and at the close of each exercise are questions, the following being taken from the first eight groups: "Water has

its greatest density at 4°C.; do all other substances behave in a similar way?. . . .Did you notice a change of color in the (Bunsen) flame as the glass tube became hot? Explain. . . . Would oxygen burn in any other gas? Do all oxides give up oxygen when heated? What part does water play in the rusting of iron?. . . . Why will certain metals displace hydrogen from acids when others will not?. . . .Is hard water injurious as a beverage? If "students who have had no previous training in chemistry" can answer such questions in the first few weeks of this course, it is a wonder-worker. From a scientific standpoint this text and manual are creditable; from the standpoint of good teaching they leave much to be desired.

W. C. MORGAN

The Story of Copper. WATSON DAVIS, C.E. The Century Company, New York and London, 1924. xix + 385 pp. 56 figures and illustrations. 14 × 20.5 cm. $3.00.

The author has written the story of copper from the days before recorded history to the present time. In the first chapter his imagination has painted a beautiful picture of the probable discovery of the use of copper by Neolithic man. In each succeeding chapter the history of copper is further developed. Its occurrence in nature, methods of mining and of winning the metal from its combinations are well described in terms that are not too technical. Its place among the metals and alloyed with other metals is explained and its many uses are enumerated. The alloys and compounds of copper are discussed in detail and their uses in peace and war in the home and in the industries pointed out.

The purpose of the author is evidently to point out how closely copper and modern civilization are connected. In fact he shows that as man has discovered new ways and means of utilizing copper so has civilization advanced until finally our modern civilization is controlled by copper.

The book contains much valuable information but the author has included entirely too much detail to make the book interesting reading except for those who are particularly interested in the subject. It fills a gap in the popular chemistry of the metals and on the whole must be considered as a valuable contribution in the field of popular chemistry. K. S. TESH

States of Aggregation. PROFESSOR G. TAMMANN (Gottingen). Translated by ROBERT F. MEHL, PH.D., from the Second German edition. D. Van Nostrand Co., New York. xi + 297 pp. 128 figures. 13.5 × 21.5 cm. $5.00.

Professor Tammann presents in this book a thorough discussion of the changes in the state of matter in their dependence upon pressure and temperature. It embodies the ripe experience of this author as a result of a dozen years of active experimentation in this field, of the cooperation of numerous students in the work and of the important contributions of others, notably P. W. Bridgman of Harvard. The book is, in reality, an intensive treatment of one component systems not only in their stable states but also in the unstable states which precede. The book is a classic both in the style of its presentation and the fullness with which the subject is presented. The serious student of physical chemistry, having made himself acquainted with what an ordinary physical chemistry text can teach him concerning one component systems can profitably turn to this book and see the extent of fundamental knowledge that is included under this title. He would rise from the task thoroughly exercised in thermodynamics, molecular theory, structure of liquids and crystals, transition phenomena between states of aggregation and the velocity with which such processes occur. In this last respect, reference might have been made to the recent work on the velocity of growth of crystals from vapors, which work is very informing concerning the nature of surface forces and the mechanism of crystal growth. The book would serve, too, as a model of the varied resources available for the solution of any problems. As such alone it has a great value.

Dr. Mehl has given a good rendering of the German text although in certain spots the original "shows through." The book is well printed and published. The diagrams are, in the main, clear and well reproduced.

HUGH S. TAYLOR

General Chemistry. HORACE G. DEMING. Second edition, thoroughly revised. John Wiley & Sons, Inc., New York, 1925. xvi + 650 pp. 13.5 × 21.5 cm. $3.50.

The author has retained the general plan of development of the subject used in the first edition (for review see THIS JOURNAL, **2**, 226, 1925). The opening chapters have been entirely rewritten, the material in them simplified, and the order of presentation of topics changed, more especially to meet the needs of students who have had no previous training in chemistry. To the main body of the book has been added a fairly full discussion of the elementary principles of electrochemistry. The treatment of organic chemistry has been somewhat curtailed, although some of the very recent developments in industrial organic chemistry receive consideration.

The first edition of the book was reprinted three times within a period of less than two years. In its revised form the book has lost none of the qualities that were responsible for its favorable reception, and it seems to have gained in clearness and smoothness of approach in the introductory portion. H. H. LLOYD

Physiological and Clinical Chemistry. WILLIAM A. PEARSON AND JOSEPH S. HEPBURN. Lea & Febiger, Philadelphia and New York. First edition, 1925. xvi + 306 pp. 30 illustrations. 14 × 20.5 cm. $4.00.

The scope of this book which is divided into two parts is perhaps best indicated by the titles of its chapters: (Part one), Physiological Chemistry—Quantitative Analysis; Organic Chemistry; Carbohydrates; Proteins; Enzymes; Chemical Composition of the Tissues of the Body; Foods, Their Chemical Composition and Metabolism. (Part two), Clinical Chemistry—Salivary and Gastric Digestion; Intestinal Digestion; Feces; Blood and Cerebrospinal Fluid; Urine; Milk; Water Analysis and an Appendix.

In looking over these titles one finds no chapter on lipins. This important group of substances is covered by references to fats and some other lipins which are scattered throughout the book and, on the whole, are brief and inadequate.

There are a number of features of this book that stand out, but it is to be regretted that they are not commendable. The first is the absence of any attempt to furnish the reader with a bibliography; which naturally discourages collateral reading on the part of the student and, at the same time, weakens the text. Again, one has the uncomfortable feeling that there are too many tests given (many of them antiquated) that are based on the same fundamental principle, for example: one finds nine (9) sugar tests based on the reduction of salts of heavy metals. Furthermore, the selection of the principal tests, in many instances, seems to have been made without regard for efficiency, for example: on page 59 Trommer's test is mentioned first, while Benedict's qualitative test is placed third and its procedure is incorrectly given; on page 163 dimethyl-aminoazo-benzene is suggested as an indicator for qualitatively testing for free hydrochloric acid in the gastric juice, Gunzberg's test being second choice; on page 165 Uffelmann's test for lactic acid in the gastric contents is placed ahead of Kelling's.

The text contains a number of definitions, statements, and descriptions that are defective. On page 65 the description of the polariscope and its use in sugar determinations is vague and deficient; the definition of acidosis on page 231 is incomplete and misleading; the statements on pages 228 and 232 regarding hyperglycemia and glycosuria are ambiguous and unexplained; the paragraph on page 190 regarding intestinal parasites is all too brief and ends with the statement that the parasites "may be identified by their appearance and by their eggs," but no pictures of the parasites or diagrams of the ova are to be found anywhere in the book.

This volume cannot be recommended as a text, either to the wide-awake medical student or the up-to-date practitioner, in its present form. It takes too much for granted; is too general in its statements, a number of which remain unexplained; it lists, in abundance, tests which have fallen into the discard years ago and fails to accurately describe procedures for other tests; it is defective in matter and finally contains no bibliography worthwhile. H. BOYD WYLIE

Inorganic Quantitative Analysis. HAROLD A. FALES, PH.D. Century Co., New York, 1925. xii + 493 pp. 13 × 20 cm. $3.50.

When I undertook the review of this book I anticipated that the reading of it might be helpful to me but I never thought that any quantitative chemistry would prove really interesting to one so far from that part of the science as I am: The very first chapter caught my attention; it was admirable in its clarity and in the thoroughness with which the essential was outlined without a mere heaping up of words and the farther I went the more convinced I became that this is the best book of its kind that I have ever had the pleasure of reading. Anyone with some experience and a certain aptitude can carry out quantitative determinations provided everything goes right but there are not so many who find pleasure in such a mechanical approach. Here we have presented to us very minutely the manipulative requirements of each type of determination together with a lucid description of the underlying theoretical considerations. As soon as we approach the subject from such a point of view it ceases to be mechanical and becomes a very interesting chapter in applied chemistry. It is unnecessary to choose particular chapters of Dr. Fales' book to emphasize the truth of these statements, all one has to do is to compare the treatment of such a subject as oxidation and reduction methods with the treatment usually found in quantitative texts.

The book is not primitive in any sense and it goes so far as to require the guidance of a good teacher to carry the average student of quantitative chemistry through it. However, it ought to prove an admirable text.

In addition to this advantage it seems to me that it is easily the best small text for the chemist who uses quantitative chemistry after he has left the university. It will save the practicing chemist from the pitfalls which he is so apt to encounter when he goes from the class-room to the professional application of his methods. It will do so because it underlines the theory so clearly that he will be able to think himself out of the difficulties instead of guessing.

The book is so good that it seems hardly fair to point out some of the very minor shortcomings which have impressed themselves upon the reader. First of all I should place that carelessness in wording which seems to be inherent in the writings of most of us today. Here this carelessness never causes ambiguity but it does cause an unpleasant impression on the ear, *e. g.*, "one of the favorite elements to be determined oxymetrically is iron."

The book is good. We need more like it.

R. E. ROSE

A FEW MOMENTS WITH THE BUSINESS MANAGER

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